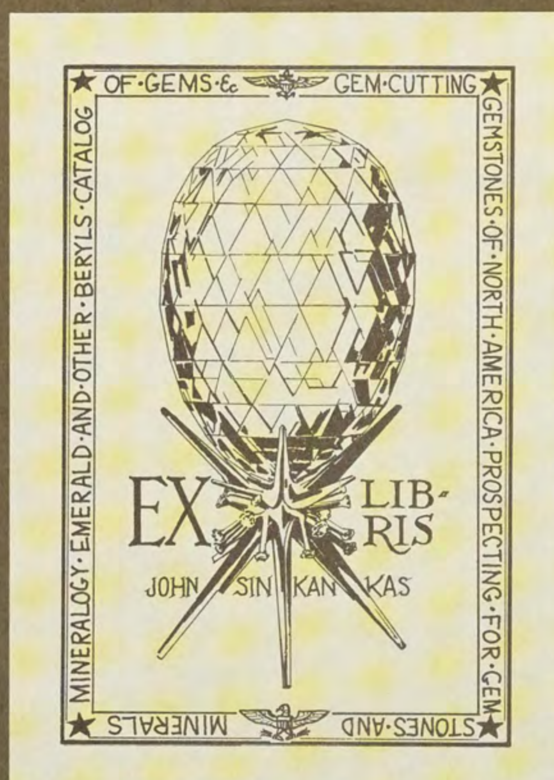
Report ON

SAPPHIRE FIELDS OF ANAKIE

BY

B.Dunstan, F.G.S.



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THE SAPPHIRE FIELDS OF ANAKIE.

(REPORT ON, BY B. DUNSTAN, F.G.S., ASSISTANT GOVERNMENT GEOLOGIST.)

[*With 2 Maps and 12 Plates.*]

LETTER OF TRANSMITTAL.

THE HONOURABLE THE MINISTER FOR MINES, BRISBANE.

Geological Survey Office,
Brisbane, 22nd January, 1902.

SIR,—I have the honour to forward herewith Report on the Sapphire Fields of Anakie, with two Maps and twelve Plates, by B. Dunstan, Assistant Government Geologist.

I have, &c.,
WILLIAM H. RANDS,
Government Geologist.

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1.—INTRODUCTION.

For several years past sapphires have been known to occur in a number of localities near the small railway station of Anakie in Central Queensland, and a report was written on the subject by Dr. R. L. Jack in 1892,* giving details of their occurrence and of the prospecting work carried on up to that time. Latterly considerable attention has been drawn to their value, and also to the large area of country over which they have been found, and to the extensive deposits within this area which have not been explored.

There has always been a tendency with those engaged in the mining of sapphires at Anakie to say as little as possible about the industry, as they were afraid public attention would be drawn to it. This attention they have been very careful to avoid as, so they say, miners would be attracted to the field and more gemstones would be obtained than a market could be found for, and a consequent depreciation in their value would result. Without expressing an opinion as to the wisdom of this policy, it might be stated that publicity would also have the effect of attracting the attention of buyers and dealers to the occurrence of the sapphires, and this might more than counterbalance the effect of greater production.

Taking into consideration the fact—and a fact that must be pointed out at the beginning—that there are peculiarities in colour in the Anakie sapphires by which they can be distinguished from foreign sapphires, greater publicity would no doubt tend to establish the stones as purely Australian productions, and would tend to give them a value uninfluenced by their comparison with those produced in other parts of the world.

Parcels of Anakie sapphires have been sent to English, American, and Continental dealers by miners on the field and also by others interested in the development of the industry, but while some of the dealers have become regular buyers of the stones, others do not look on them with favour. This peculiarity of colour, which is only in the blue shades, has militated against their sale, but a large proportion of the stones are of fine bright green and yellow shades, and when cut make very beautiful gems.

The hesitation which some dealers feel in buying Anakie stones is not altogether due to their colour, however, as in buying consignments of stones from the Anakie miners, the dealers are not made acquainted with the conditions which prevail on the sapphire fields, and they have no idea of the

* Report on the Sapphire Deposits and Gold and Silver Mines near Withersfield.—R.L.J. By Auth.: Brisb., 1892. (G.S.Q., 81.)

extent of the deposits from which the stones are obtained. In consequence of this lack of knowledge they do not know if a fair supply could be maintained, nor whether higher prices will have to be paid, should they, by any means in their power, create a greater demand for the sapphires.

Let it be known that the field is a large one, that the extent of sapphire wash is second to none in the world, and that a constant supply of stones could be maintained—facts which will be established in the following pages—then there will be no cause for complaining that markets cannot be found for the stones. The greater demand for the sapphires will be met by a greater production, and with a greater production the dealers will not be contented to wait for consignments to be forwarded to them, but will themselves visit the field periodically, and buy direct from the miners, a condition of things satisfactory to all concerned.

An illustration may be given of the effects of reserving from the dealers and the public any information about the fields, and the hesitancy on the part of the dealers to state that any good stones they might want to dispose of came from an unknown locality such as Anakie, or on the part of the public in buying stones if they be told they came from such a place. The following extract was taken from a letter received by the writer from a representative of a Geneva firm of lapidaries and dealers. It states that "Fine sapphires, equal to those from Burma, have been found amongst the Australian gemstones. Most of these are sent to Germany by dealers, where they are sorted. The best gems are afterwards sold separately under another name, and the inferior lots sold as Australian."

In the following pages it is proposed to describe the various gemstones and other minerals found on the sapphire fields, to give an account of the geological features of the deposits containing the stones and the formations with which they are associated, the source from which the sapphires have been derived, methods of sapphire mining, some historical notes, a short account of the principal foreign sapphire deposits for purposes of comparison, and the occurrence of the first diamond recorded from Central Queensland.

2.—TOPOGRAPHICAL FEATURES.

The Anakie Railway Station is situated on the main Central Queensland Line, and is twenty-six miles west from Emerald and 192 miles west from Rockhampton. Its general position is indicated on the small plan attached to the large map. It is from Anakie as a centre of radius the sapphire fields extend both in a northerly and westerly direction.

The Drummond Range is the main watershed of the Anakie District, having the Zamia, Anakie, and other ranges branching off from it. From Bogantungan the Drummond Range extends northerly, while from a point a few miles north of this town the Zamia and some smaller ranges extend north-easterly. The Anakie Range trends more towards the east.

The most prominent landmark of the district is Mount Leura, a peak about 2,000 feet high. Although parts of the Anakie Range a few miles to the south and the Drummond Range away to the west are much higher, yet the surrounding country is comparatively low, and the mountain in consequence very conspicuous. Numerous other peaks are scattered over the country, and all are remarkable for their isolation from one another. They are, there is no doubt, remnants of a basaltic lava which once flowed over the granite now exposed at their base.

The whole of this area is drained by tributaries of the Nogoa River, of which Theresa Creek is the principal affluent. It is the smaller branches of Theresa Creek, however, such as Central, Tomahawk, Retreat, Argyle, and Sheep Station Creeks, about which most of the deposits of sapphire wash are to be found. Over most of the country drained by these creeks there is no difficulty in travelling, but some of it is very mountainous, while other low-lying portions are impenetrable from being covered with a dense brigalow scrub.

3.—GEOLOGICAL OUTLINES.

Granite, and its varieties, form the oldest and most extensive system of rock-masses in the district. This will be seen from the accompanying maps and sections. Gneisses, schists, and slates rest against the granites, and the gradual changes of these rocks from one to the other can be observed in places, and from which it is assumed that the granite is of metamorphic origin. No indications were noticed of the granite being intrusive,

The gneisses and schists are everywhere found to be in contact with the granite, sometimes forming masses surrounded by this rock, but usually as belts, with the granite on one side and slates on the other. The schists change imperceptibly into slates, and for this reason the boundary between the slates and the gneisses and schists is only approximately shown on the accompanying maps. In some localities slates rest directly on the granite without any appearance of gneiss or schists as intercellated rocks, but such occurrences are not frequent.

Intrusive rocks occur of two kinds—acidic and basic. The acidic rocks, consisting of pegmatite, felspar porphyry, and felsites, are in great abundance, and traverse the granites and gneisses in all directions. The basic rocks are hornblendic, and are either massive hornblende rock or else diorite. There are also outcrops of massive epidote rock and garnet rock in places, resulting probably from the alteration of limestones in contact with the granite.

A very conspicuous break exists between the granites, gneisses, schists, slates, and intrusive rocks, taken as a whole, and the next younger formation—the Drummond Beds. Shales, sandstones, and conglomerates make up the greater mass of this series, and they abut on the granite and some of the other rocks with a junction well defined in many places. From a distant view, these beds appear horizontal where they are not close to the granite, but where they come in contact, their dip is between 60° and 70°.

The rugged features of some of the mountains previously referred to are due to the prominence of the conglomerates of the Drummond Beds, whose outcrops are approximately parallel to the line of junction between the sedimentary series and the granite, although some distance away.

The series comprising the shales, sandstones, and conglomerates are placed as Drummond Beds, but they may belong to the " Star" Formation. No fossils have been found in them, neither was any detailed stratigraphical work carried out on them.

After the deposition of the sediments to form the Drummond Beds, of probably Permo-Carboniferous Age, there was a long interval during which either no material accumulated at all, or else it has being washed away without leaving behind any traces of its former presence.

There are no representatives of any of the Mesozoic Formations to be found *in situ* either above the Drummond Beds or on the granite or slates, and although the remnants of a formation later than the Drummond Beds are to be found as boulders in Tertiary and Recent Alluvial Deposits, otherwise all evidence of the existence of Mesozoic Rocks have been destroyed.

These remnants of a pre-existing formation consist of boulders of a hard flinty quartzite, so peculiar in their being found as a surface formation and so general in their occurrence in Central Queensland, that they have been designated as "billy," a local name given to them by the alluvial gold miners of Clermont.

This "billy" has usually and, perhaps, arbitrarily been placed as of "Desert Sandstone" Age, and without going into the question of whether this view is right or wrong it will be provisionally placed here as such. It occurs exclusively as boulders in the alluvial sapphire deposits, and from its abundance and distribution probably has been derived from what must have been a very extensive formation.

One remarkable feature in the occurrence of the "billy" is its being limited to sapphire deposits formed below the junction of the Drummond Beds and the granite. The country in which all the creeks have their source is composed of these sedimentary beds, while the country lower down is all granite. In an examination of the debris in the channels of the present and the pre-existing streams, this feature in the occurrence of the "billy" is to be noticed.

Basalt is found in a great number of places, but there are no extensive flows of it existing at the present time. A large area of it must have once existed, but denudation has removed almost all of it, leaving only a capping on the tops of the hills and mountains.

The sapphire deposits are distributed over a large area, but nearly all are confined to the granite country. The deposits occur on the banks of the creeks, but very rarely are they found in the beds of the present streams. Generally they are high above the beds of the creek, on the sides or base of the low hills; nevertheless, they are found to be roughly parallel with the creeks in most places.

There is a difference of about 500 feet between the altitude of the deposits on the eastern or lower portion of the district and those on the western or mountainous region towards the source of all the creeks; but sapphires were found in the basalt, at an altitude of 500 feet above the highest alluvial deposit.

The recent *débris* of the creeks do not carry sapphires, or, rather, none have been found in them. The sapphires do not travel very far, and if the deposits which contain them on the sides of the ridges have been washed away, the sapphires will still be found just below the remaining portion of it in the gullies, perhaps only a short distance away.

Map 1 is a geological sketch of the whole of the district examined, and is on a scale of one mile to the inch. It embraces an area of about 400 square miles, of which fifty square miles contain deposits carrying sapphires of more or less value.

Altitudes have been taken of the more important places, and show the high position of some of the deposits of sapphire wash to the west of the area when compared to the lower ones to the east. In the topography of the country some new features are added, as the old maps on which the work was based are incomplete in many respects.

Geological boundaries for the most part are only approximately shown, as the work was directed more towards the occurrence of the sapphires than to the details of the geological formations.

Map 2 is on a larger scale, and shows in greater detail the position of the sapphire deposits of Retreat Creek, Policeman Creek, Iguana Flat, and Sheep Station Creek, together with other geological and topographical information.

4.—GEOLOGICAL FORMATIONS.

(*a*) Granite Rocks.

It will be observed on perusing the accompanying map (1) that on the northern side of the district granitic rocks form a large area. The rocks are mostly syenite, with intrusive dykes of red felspar porphyry, the surface of which in places is very much decomposed. In the small rivulets abundance of magnetite is to be seen.

granite?

This part of the country is the watershed dividing Tomahawk and Serpentine Creeks, trending north-east, from Carbine, Cattle, and other creeks trending easterly. Syenite occurs on the Clermont-Anakie Road, from Cattle Creek on the north, down to the foot of Mount Leura, and both to the east and west of the road in numerous localities syenite and granite outcrop on the surface. The granite rocks pass south of Mount Leura as far as Retreat Creek, and westerly as far as shown on the map.

Syenites, with similar porphyry dykes, occur on Sheep Station Creek, and granite outcrops occur along Iguana Flat. Some of the outcrops of granite in the gullies of Iguana Flat leading down to Sheep Station Creek are a coarse-grained muscovite granite.* Other similar occurrences are to be seen in the neighbourhood of the junction of Retreat and Spring Creeks.

* pegmatite?

In the whole of the granite area no indications were seen of auriferous reefs or any deposits of other minerals of commercial value, except near or at the contact of the granite with the metamorphic rocks or with the slates or diorite intrusion.

It has repeatedly been asserted that stream-tin occurs in some of the watercourses where the granite is decomposed. All the black sand examined, however—and some of it, it may be stated, came from Mount Ball, where at one time prospecting for tin was in operation—proves the absence of this mineral. The presence of black tourmaline in abundance, and also titanic iron, pleonaste, and magnetite may indicate how the mistake arose in supposing stream-tin to occur here.

There has been a tendency with some miners to compare this field with the tinfields of New England in New South Wales, because at Anakie there are most, if not all, of the minerals to be found which in New England are associated with stream-tin. Stream-tin, of course, might be found here, but the opinion may be expressed that the possibilities are very remote.

Pegmatite granite occurs in a great number of localities within the granite area. A section of a specimen from Mount Leura shows tourmaline as idiomorphic crystals in quartz and felspar (Plate 3, Fig 6). It occurs as dyke masses in the finer-grained granite.

(*b*) Metamorphic Rocks.

The area over which the metamorphic rocks are exposed is much more limited than that of the granite. They occur as well-defined belts, sometimes in contact with the granite and sometimes with the slates. One of these belts, starting from Mount Bullock on the north side of Retreat Creek, extends northerly across Policeman Creek. Another belt extends from the eastern side of Iguana Flat and crosses Retreat Creek and Spring Creek in a southerly direction. It is on a portion of this belt that the Withersfield Sapphire Company has its freehold property. Another smaller outcrop exists near the Mount Clifford Mine, and spreads across Ruby Creek to the east of the old alluvial gold workings, known as Basalt Hill Diggings. An outcrop also occurs at the sapphire mines of Mr. Hunt. (*See* Map 2.)

Portions of these metamorphic belts are auriferous, and several lodes are known to occur in them, but nothing of importance has yet been developed. Gold has been found in the gullies at the base of Mount Bullock, and very probably has been shed from the outcrops of quartz reefs in the vicinity. At Sheep Station Creek there is a small outcrop of a fine-grained hornblende schist, sections of which show it to be hornblende, quartz, and red garnet.

(*c*) Slates.

The development of slate formation, so far as concerns the area shown on the accompanying map, is confined to the portion on the eastern side, but there is evidence, however, of its continuation much further north and north-east. The slates are argillaceous, talcose, micaceous, and occasionally quartzose.

At Mount Pleasant, between Ruby and May Creeks, the rocks consist of siliceous and clay slates, the beds being vertical and having a north and south strike. The slates from here trend northerly to the workings of the Mount Clifford Mine, where they have been disturbed by diorite intrusions.

To the north of Policeman Creek, about nine miles north of the Anakie Railway Station, ironstone "blows" are very common in slate formation. They consist of clayey limonite and hematite and usually contain gold, but the small amount of prospecting work done on them has not revealed anything payable. These ironstone lodes or "blows" are certainly worth further attention, but the gold will probably be very fine and coated, and consequently, even if payable, its presence will not be easily detected. Copper lodes have been worked in the slate formation, and possibly copper once existed in the ironstone exposed, but which has since been removed by surface waters. Below the surface some of the ironstone has proved to contain copper as well as gold, but all mining operations in the district are in the development stage.

At Mount Clifford, which is about half-a-mile north-west of Mount Pleasant, work has been in progress intermittently for some years back. Both gold and copper has been found in a formation between outcrops of diorite and slate, and although a considerable amount of prospecting work has been carried out and machinery erected for treating the stone, so far all the work has not produced any tangible results.

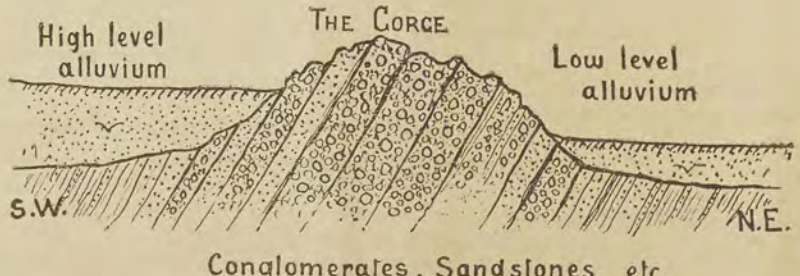
(*d*) Drummond Beds.

This formation, which was only given cursory attention, is separated from the granite by a north-west and south-east line of junction. At the westerly portion of the Anakie Range shown on the map, there seems to be a south-eastern terminus of a disturbed zone in which all the rocks have been tilted against the granite, and where the sandstones and conglomerates have withstood weathering action better than some shale beds below them. The sandstones and conglomerates, more especially the latter, have become prominent features on the north-westerly extensions from the Anakie Range, while the shales below form the depressions in the landscape features to the north-east of them, as shown in the section on Plate 12.

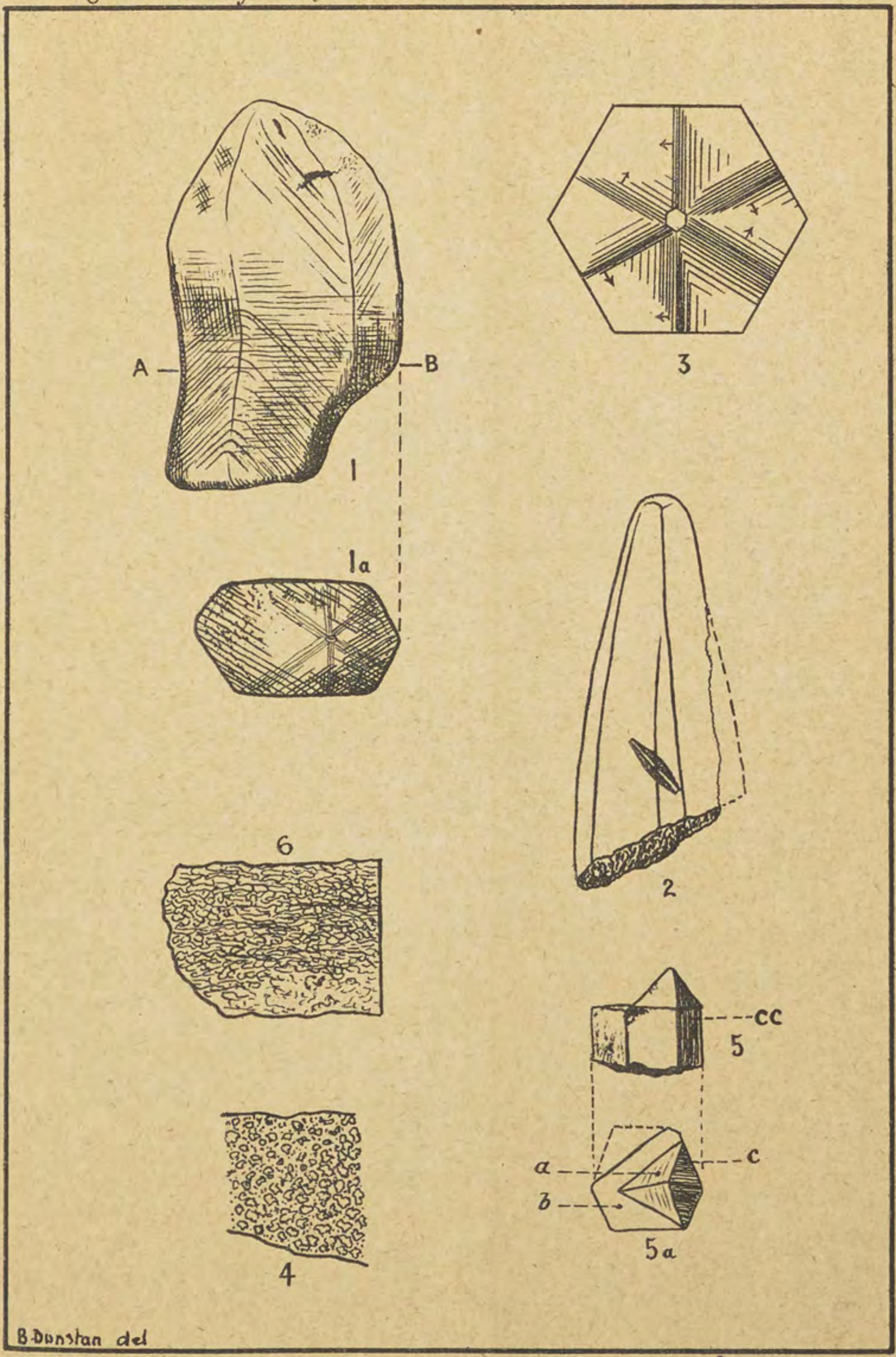
On Tomahawk Creek, south-east of Mount Hoy, the bed of the stream is very much confined between precipitous walls, and is known as the "Gorge." Here the highly inclined conglomerates are exposed in some fine sections, and show unmistakably their interstratification with the sandstones. Some doubt was felt as to what formation to assign the conglomerates to, whether they should be regarded as a portion of the Drummond Beds, or if they belonged to the "Desert Sandstone," but the observation cleared up all doubts on the matter. Other somewhat similar sections were seen subsequently.

The following sketch (Fig. 1) represents a section of the belt of conglomerates and sandstones where Tomahawk Creek has broken through it, and shows the bank along the creek at one part of the gorge.

Fig. 1.



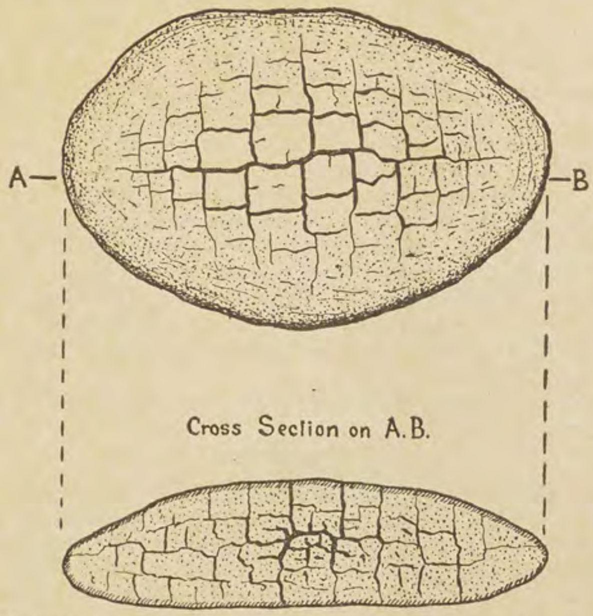
Section at the "Gorge" at Tomahawk Creek.



Corundum Crystals

The shales on the north-easterly side of the conglomerates contain abundance of septarian nodules, some of which are over a foot in diameter, but usually much less. From their shape and the markings on their surfaces they have been called "fossil turtles." Fig. 2 shows the surface markings and a section through the middle of one of them.

Fig. 2.



Septarian nodule ("Fossil Turtle") from Ten-mile Gully, south-east of Mount Hoy.

In places small nodules of less than one inch in diameter are imbedded in an argillaceous limestone, of which microscopic sections show a well-marked septarian structure.

Regarding the steep inclination of the strata belonging to the Drummond Beds, Dr. Jack has observed that "at Bogantungan is an axis of a synclinal trough, and that as far eastward as Withersfield the dip is towards the west."* With this the writer's observation agrees, and would further show that at the edge of this basin or trough, where the formation is in contact with the granite, the beds have been much disturbed. The conglomerate belt, which is such a conspicuous feature in the western portion of the sapphire fields, does not seem to have come under previous observation in the district, so probably is of local development.

It has been previously stated that the slates, schists, gneiss, and granite may be looked upon as one series in which the lower beds have become granite by metamorphic change. It does not follow from the tilting of the conglomerates and the other beds, where they are in contact with the granite, that a movement of the granite has taken place subsequent to the deposition of the sedimentary beds. It may be due to a depression taking place in the sedimentary beds as much as to the elevation of the granite. These beds have been intruded by rhyolites, a reference to which will be made further on.

(*e*) Diorites.

At Mount Clifford some mining operations are closely associated with the diorite, details of which were published three years ago.†

Referring to the diorite therein, it is stated that—"The slates are intruded by diorite, which forms conspicuous masses where it crops out on the surface, and the reefs of the Mount Clifford Mine, and others in the locality, are formed at or near the junction of the slates and schists with this igneous rock. There seems to be two intrusions of this diorite. One of the diorites, however, is more decomposed than the other, and the texture is somewhat different, as well also as the state of aggregation of the minerals composing them. The reefs which come in contact with the more decomposed diorite are said to be quite barren, while those in contact with the less decomposed diorite are found to be auriferous. By the miners the former is called the old diorite, while the latter is referred to as the new."

Thin sections of these were examined, from which it was observed that—"The diorite adjoining the barren reefs proves to be a rock containing a large proportion of partly kaolinised felspar (the grey mineral seen in hand specimens), and to this is due its weathered appearance. The hornblende (the black mineral) is very fresh in places, and only a small portion of it is decomposed. The characteristic cleavage is very marked, and pleochroism is to be observed in places under polarised light. Magnetite occurs in rather coarse grains, and iron pyrites is found sparingly in the section. In the diorite in contact with the auriferous reefs and "deposits" the felspar is much clearer than in the one just described, and under crossed nicols multiple twinning is shown quite distinctly. The hornblende is nearly all decomposed, and faint pleochroism is only seen in very small patches of the mineral remaining unaltered. Magnetite occurs disseminated throughout the green chloritic decomposition product of the hornblende, and pyrites is present in some abundance."

On the south side of Retreat Creek, between Spring and Ruby Creeks, and close to the Poverty Hill sapphire workings, a low outcrop of diorite is exposed, while further down Retreat Creek in the

* Report on Sapphire Deposits and Gold and Silver Mines near Withersfield.—R.L.J. By Auth. : Brisb., 1882. (G.S.Q., 81.)
† Mount Clifford and other Mines near Anakie, Central Queensland.—B.D. By Auth. : Brisb., 1898. (G.S.Q., 127.)

deposits of sapphire wash, pebbles of a very similar rock also occur. The presence of the rock *in situ* at Poverty Hill is suggestive of a possible origin for the diorite pebbles in the wash, and also indicates the direction from which the material forming the sapphire deposits has come.

A coarse-grained diorite is exposed on the old Aramac Road, above Reid's Waterholes, the lagoons on Sheep Station Creek. The outcrop is a small one, but conspicuous because of its angular weathered surfaces. Macroscopically the rock is very coarse-grained, has a dark bluish-green colour, and contains large porphyritic crystals of hornblende, this mineral in fact forming the main mass of the rock in some parts of the outcrop. Microscopically, thin sections show the hornblende to be pale-green, and associated with irregular patches of magnetite.

(*f*) Rhyolite.

Masses of this rock are exposed near the junction of Argyle and Retreat Creeks. One of the outcrops is on the north side of Retreat Creek, and is the terminal point of a range extending south-east from Mount Hoy, while about a mile away on the south side of Argyle Creek there is another outcrop.

Disintegrated thundereggs

It was observed that in the sapphire deposits, and in the recent alluvium east from these rhyolite hills, there were pieces of chalcedony, somewhat like shells in form, but evidently pseudomorphs after lithophyses, the hollow spherulites. Sometimes they have two convex sides with radiating costæ, but frequently have as many as six sides. In ascending Retreat Creek it was noticed that the pseudomorphs were absent from the river *débris* above the rhyolite outcrops, and their source, on being looked for, was discovered in these outcrops. The lithophyses when taken out of the surrounding rock are like marbles in shape and size, the interiors of which are either lined or filled with chalcedony. In weathering, the lithophyses crumble away, leaving intact the pseudomorphs, which ultimately find their way down the watercourses.

The rhyolites are close to the junction of granite and the Drummond Beds, but they appear to be surrounded by the latter on all sides.

(*g*) Billy.

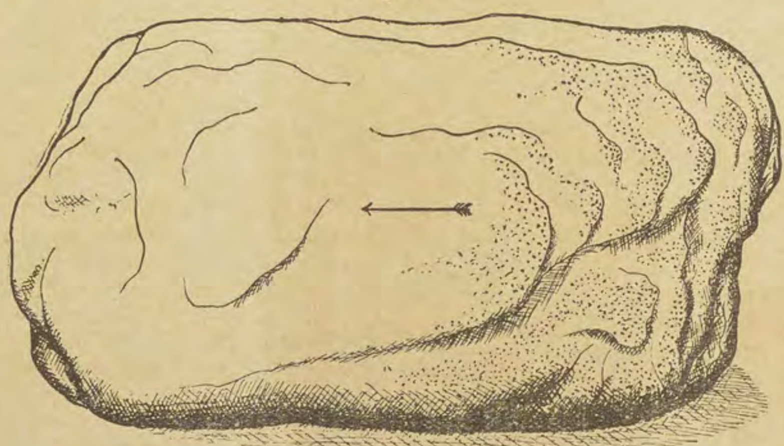
The term "billy" refers to a quartzite rock which has been formed probably from the surface silicification of sandstones. It has been referred to in previous Reports.*

The occurrence of this quartzite rock is very general in all the eastern parts of the field where sapphires are found. At Retreat Creek, Sheep Station Creek, and Policeman Creek, the rock is invariably associated with the sapphire deposits, and is not found any distance away from them. "Billy" is commonly known amongst the Anakie miners as "sapphire boulders," and where found in unprospected localities is always looked upon as an indication that sapphires probably exist close by. Therefore, where these boulders are met with they are usually turned over and an inspection made of the soil beneath and around them. On the abovementioned creeks the "billy" is found with other boulders of diorite, basalt, and quartz, the latter sometimes being in blocks over a foot in diameter.

On the Withersfield Sapphire Company's Reward Claim on Sheep Station Creek (*see* Map 2) the sapphire wash has been almost completely hidden by boulders of "billy," some blocks of which weigh several tons. An examination of these large blocks shows that they have not been shifted along the old channel in which they and the sapphires have been deposited, although possibly they formed a bed a few feet higher than their present level. It was also observed that the largest blocks retain the horizontal position in which they were deposited as a bed, and peculiarities in the grain of the stone indicate the close relation of the blocks to one another.

In appearance the blocks seem to have been water-worn, but this effect has not been produced altogether by the action of water. The first stage in the breaking up of the beds has been the production of fractures to often form angular blocks. The next stage would be the rounding of the corners of blocks by atmospheric weathering, as other rock masses are rounded. The third stage is the polishing of these surfaces by the action of water carrying very little suspended matter as abrading material. The final stage is the undercutting of the boulders by strong currents of water, carrying both coarse and fine material in suspension to destroy the fine polished surfaces on the boulders where they have faced the impact of the material coming down the stream. It is under such conditions the "billy" boulders have been formed, and the sapphires deposited amidst them. Fig. 3 represents one of them.

Fig. 3.



Boulder of "Billy," W.S.S. Reward Claim.

The arrow indicates the direction of flow of water carrying sapphire-bearing material. Dotted portions in the sketch indicate the roughened surfaces produced by the impact of the sapphire bearing material.

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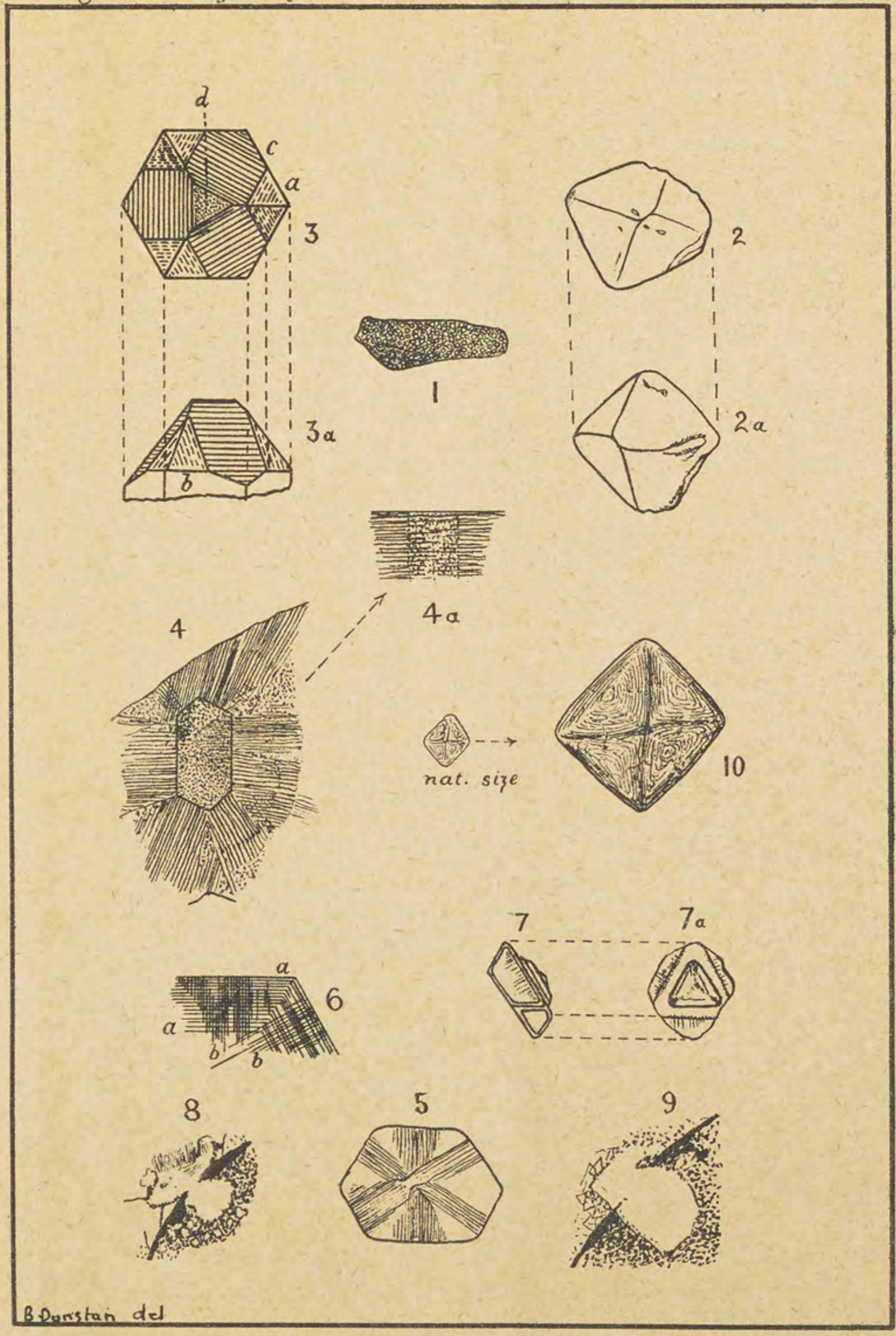
*1. Geology of the Dawson and Mackenzie Rivers, by B.D. By Auth.: Brisb., 1901 (G.S.Q. 155) p. 20.

2. The Permo-Carboniferous Coal Measures and Associated Formations, by B.D. By Auth.: Brisb., 1900 (G.S.Q. 148), pp. 5, 6.



Corundum, Pleonaste, Diamond.
&c.

The creeks north-westerly from Mount Leura—*i.e.*, Serpentine, Koski, Tomahawk, and Central Creeks—are remarkable for the rarity of "billy" in the sapphire deposits close to them. At Retreat Creek, near its junction with Argyle Creek, the rock is common in the river shingle and in the sapphire wash there, but on the other side of the Aramac Range, a few miles to the north-west on the above-mentioned creeks, it is not to be found. This rather shows that the "billy" and its varieties (ironstone billy, white billy, puddingstone billy, and billy conglomerate) are not the rocks from which the sapphires originally came, which, it may be stated, is a view contrary to that of the miners on the field.

Further on it will be shown how the deposits which now contain these boulders mixed with the sapphires came to occupy their elevated positions on the ridges and spurs.

If it be taken for granted that the "billy" has been formed at or near the place where it occurs in large boulders, it would follow that it once covered a portion of the country where now only granite, syenite, and metamorphic rocks are exposed, and because in this area it is confined to portions where sapphires occur, it should also follow that it was not spread over the surface of the country, but was confined to the channels of the old watercourses.

In travelling by road from Clermont to Anakie, billy was observed at intervals all along the route. At Clermont the billy is associated with gold in the alluvial deposits, while between Clermont and Anakie it contains both gold and sapphires. In consequence of this, a difficulty is felt in determining, outside the Anakie Fields, whether this rock is an indication of gold or of sapphires.

Microscopic sections show that small pebbles of sandstone in the billy have been completely altered, and sometimes difficult to distinguish from the surrounding finer material. The quartz grains in the pebbles show a second growth on the portions which have been abraded by water, and where the grains have appeared on the outer part of the pebble they have grown out from the pebble into the surrounding material. Plate II., Fig. 8 and 9, show this structure.

(*h*) Basalt.

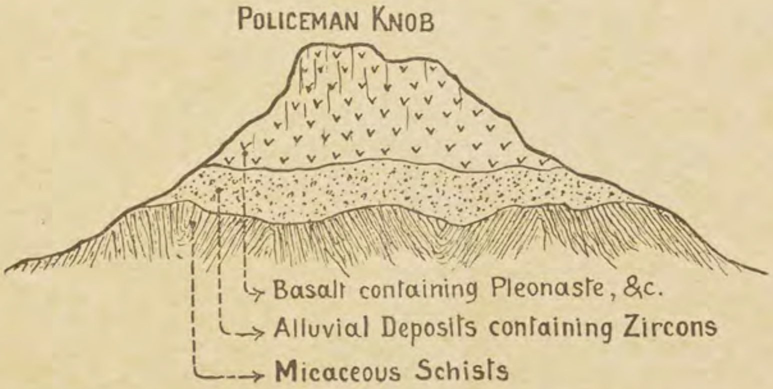
In the district very little remains of what must have been an extensive flow of basalt, and very little of this can be availed of from which to obtain information. At the same time, a number of features have been noticed in several places having an important bearing on the occurrence of the sapphires.

Probably one of the oldest alluvial deposits in the district is that at the Basalt Hill Diggings, about three miles north of the Borilla Railway Station (*see* Map 1), and this is covered by basalt. Several shafts have been sunk through this rock to test the alluvial deposits below it for gold, and, as well as obtaining gold, several other minerals have been found. These include garnets, zircons, magnetite, and tourmaline, but sapphires were not seen.

Pleonaste and olivine are also absent from the alluvial deposit, but are present in the covering of basalt, and in the soil derived from the decomposition of the basalt on the surface.

Policeman Knob is close to the southern bank of Policeman Creek (*see* Map 2), and is remarkable for the number of white and coloured zircons found in the old alluvial deposit underlying the basalt in some of the gullies leading down from the Knob. (*See* Fig. 4.)

Fig. 4.



A Basalt Covering an Old Drift.

The drift contains abundance of small white zircons, but from which sapphires are absent.

Inquiries were made concerning the presence of sapphire with the zircons, but none of the miners have heard of any being found, neither did a recent investigation reveal their presence. Pleonaste, olivine, quartz and other obscure minerals occur embedded in the basalt of Policeman Knob.

The presence of zircons and the absence of sapphires in alluvial deposits covered by basalt may be taken as an indication that the sapphires where they are found in other places have been deposited at a time later than that at which the basalt flow took place.

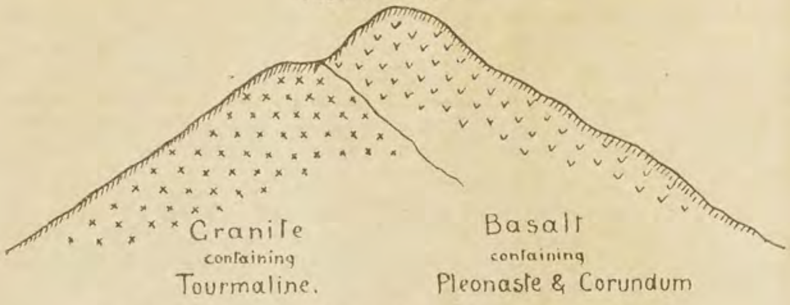
At Retreat, Policeman, and Sheep Station Creeks, boulders of basalt invariably occur with the sapphires, and pebbles of the rock are frequently found in which pleonaste is embedded. On Tomahawk Creek and other creeks in the western portion of the district basalt boulders also are present in the sapphire wash, but, as stated before, almost always without the "billy."

The basalt peaks are scattered all over the district, the three highest being Mount Leura, Mount Hoy, and Black Peak. Mount Leura is about 2,000 feet above sea-level and Mount Hoy about 1,860 feet. The altitude of Black Peak was not determined, but it is, nevertheless, much higher than Mount Leura. At all these mountains the older rocks can be distinguished at the base of the basalt, those

at Mount Hoy and Black Peak being Drummond Beds, and that at Mount Leura being granite. At Mount Leura the granite can be traced close to the top on one side, while on the other side the granite is not exposed at all. This is shown in Fig. 5.

Fig. 5.

MOUNT LEURA



The Contact of Granite and Basalt on Mount Leura.

The heights of the basalt peaks are less than that of the Drummond Range away to the west of them, but it cannot be stated if there are also volcanic peaks in that direction. There is evidence, however, that there is a general easterly decline in the height of the basalt as the distance from the Drummond Range becomes greater, so that in this direction, and perhaps also in other directions, flows of lava probably took place, and were connected with the extensive basalt areas at Tarabora, in the direction of Emerald.

The three peaks mentioned may be volcanic cones, but their peculiar shape, resulting from the splitting up of the basalt into vertical columns, cannot be taken as a guide in the matter. On the top of all of them the basalt has this columnar structure more or less developed, a feature particularly striking at Mount Hoy, where the basalt stands up in long parallel columns on the sides of the mountain.

This columnar structure is not, of course, confined to the craters or cones of volcanoes, as it occurs also in flows away from the vent, so that, from the presence of this structure, it must not be assumed that Mount Leura and the other peaks are volcanic cones. At the same time the probability of their being such is suggested from their elevated position.

Further evidence on the relation they bear to one another is supplied by their similarity in mineral composition. Their texture varies somewhat, a feature which may be due to conditions under which they solidified, and all of them are more or less magnetic. Taking a compass bearing on Mount Leura, Mount Hoy, or Mount Newsome is quite useless as the polarity of the large blocks of basalt causes the needle to deviate in all directions.

The mineral inclusions in the basalt on the tops of the mountains present many interesting features and throw some light on the origin of the sapphires. In examining Mount Hoy it was discovered that the mineral pleonaste is a very common inclusion in the basalt, but not occurring in forms which suggest crystallisation during the consolidation of the molten basalt. If the crystals have formed in the basalt, the corrosion which they have been subjected to would indicate the magma to have been molten subsequent to their formation.

A pale blue sapphire having a thick, black scaly coating on one side, together with abundance of pleonaste, was picked up on the summit of Mount Hoy. The sapphire was found at a height of 500 feet above the highest of the sapphire alluvial deposits, and although there are means by which it could have been taken up to the top from the deposits below, yet it very probably was weathered out of the basalt together with all the pleonaste with which it was found.

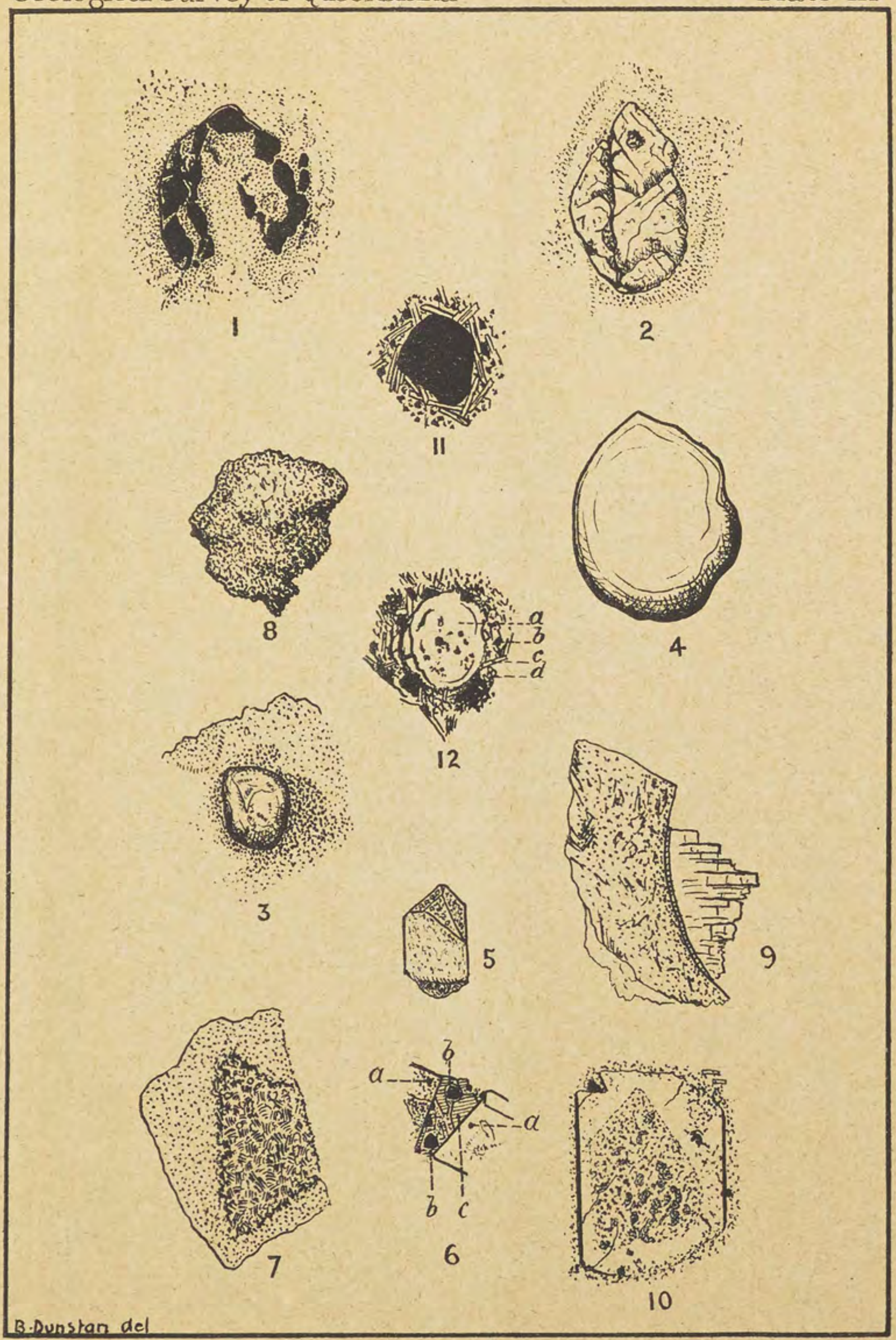
At Mount Leura a piece of bronze-black corundum was discovered partly exposed on a large face of basalt. Unfortunately there were no means available at the time by which the basalt around the corundum could be removed to show the one embedded in the other. This was the only specimen of corundum observed *in situ*. Inquiries afterwards from miners and others confirmed the discovery of the presence of this corundum in basalt, which commonly is known as "bronze pleonaste." A small parcel of stones brought by a prospector from the summit of Black Peak, about four miles south of Mount Hoy, on examination proved to contain pleonaste, titanic iron, hornblende, and two small angular fragments of corundum.

If, then, the basalt carries sapphires as inclusions, and if the basalt of those peaks once extended towards the east and north-east, then a part of the country at one time must have been covered by basalt containing sapphires, and which since then has been decomposed and washed away. The sapphires and other inclusions remaining undecomposed would lie in the watercourses on the surface of the rocks over which the basalt once existed.

What happened in the early stages in the history of the sapphire is purely speculative. Possibly the basalt has disturbed some of the metamorphic or granitoid rocks at a depth from the surface containing sapphires, and in being erupted has caught up portions of these rocks, and with them the sapphires. What is perhaps a more likely view is that the rock containing the sapphires has become molten, has altered its mineral, although perhaps not its chemical, composition, and has been ejected as a volcanic lava.

At Mount Leura, as well as the sapphire and pleonaste, other inclusions found in the basalt were hornblende, plagioclase felspar, titanic iron, quartz, and olivine, all of which show the effects of corrosion. A number of sketches of sapphires and pleonaste illustrating the effects of the corrosion by the basalt, is shown on Plates 1, 2, and 3.

Microscopic sections of the basalts indicate the Mount Leura and Mount Hoy rocks to be almost identical in every respect, but that they vary from the Mount Newsome lava in being of a fine texture. In Mount Leura and Mount Hoy sections the most conspicuous minerals are olivine and augite. In both the large and small crystals of augite the borders are corroded, while in addition the large crystals are frequently broken. Pl. 3, Fig. 10, shows a corroded crystal of augite. Olivine is sometimes well



Inclusions in Basalt

crystallised, but usually its boundaries are indistinct, also from corrosion. (*See* Pl. 3. Fig. 10.) The felspar in both lavas show corrosion, but in that of Mount Leura some crystals show well-defined boundaries, and suggest two separate crops of them.

Magnetite is conspicuous from the irregularity in the outline of the sections, from its rarity in the olivine, and also because of its abundance as dust inclusions in many of the other minerals. Pleonaste shows rounded and corroded forms with the felspar crystals packed up around it, as represented in Pl. 3, Fig. 11.

(*i*) Sapphire Deposits.

In the different workings on the field the thickness of the sapphire wash varies considerably, in some places being only a few inches thick while in others it amounts to several feet. The bottom is usually a reddish clay resting on decomposed schists and slates. Mistakes have been made in supposing this red clay to be invariably the bottom, since below the red clay another and sometimes a richer bed of wash has sometimes been found.

Some of the workings contain only medium-sized boulders, while others contain boulders too large to be removed by hand. Frequently the sapphire wash is very clayey and requires "puddling" before the sapphires can be extracted, and under such conditions the "wash" requires to be richer to pay for the extra trouble. Much of the wash is loose and friable and free from clay, and then the sapphires are obtained by "dry sieving."

No general rule can be given to determine what the deposits will be like in any particular place, as their character is affected by so many local conditions. In the claims the wash may change from a reddish, gravelly clay to a very dark, fine, friable soil, or from a black soil to one which is white and marly, all carrying sapphires; and from being a very shallow surface deposit it may change to one, perhaps seven or eight feet deep.

In the western deposits at Tomahawk Creek, and also at the other creeks in this direction, the wash is of enormous thickness. Very little prospecting has been carried on in this part of the district, so the actual depth of the wash is unknown. No surprise would be felt, however, if the wash were to be found fifty feet deep, as it rises high up into terraces far above the present streams.

In some of the workings no bottom, so far, has been found, but in these instances—on Retreat Creek—the wash has not been sufficiently rich to induce prospectors to sink deeper. Sometimes the prevalence of large boulders make the work too laborious for deeper sinking, and the ground cannot be worked without hoisting machinery. The part of the wash which carries the sapphires is often very irregular, sometimes occurring as small patches in the otherwise almost barren portions, while the sapphires in other places are generally scattered throughout the wash.

As the older formations which form the bottom of the deposits vary in composition, so does the colour of the deposits which rest on them. Where the bedrock is decomposed slates and schists, the wash is inclined to be reddish, where granite is present the wash is yellowish, and where the basic volcanic and intrusive rocks are on the bottom the wash is almost black.

The bottom as well as the wash is also very irregular, from which it may be supposed that the water in producing such effects was by no means gentle in its action. Where the wash has been removed in some of the old workings, an inspection shows the bottom to consist of a series of pot-holes, sometimes communicating with one another, but frequently having no connection at all, as shown in Pl. 11.

The mineral and rock constituents of the wash do not vary to any great extent over the fields, the most noteworthy being, as mentioned before, the abundance of "billy" in the wash of Retreat Creek and other creeks trending east, and the absence of it in most of the deposits on Tomahawk Creek and the creeks trending northerly.

The peculiar situation of the deposits in occupying the tops or sides of low ridges may be explained by referring to Pl. 9, where the changes are shown by a series of sketches.

5.—THE SAPPHIRE FIELDS.

The important deposits of the district may be separated into the following four main divisions :—

(*a*) Retreat Creek and Sheep Station Creek.
(*b*) Policeman Creek.
(*c*) Tomahawk Creek.
(*d*) Central Creek.

Several less important deposits occur (described under "Smaller Fields"), of which those of Boot and Kettle Creek are perhaps the most extensive. Isolated deposits also exist near Borilla Railway Station, at Glendariwell, and at Argyle Creek (*see* Map 1). Sapphires have been picked up on the surface of a gravelly wash at Llandeillo to the north, at the horse-paddock of Bevendale out-station, and in the direction of Peakvale Station, places not shown on the accompanying map.

(*a*) Retreat Creek.

Small patches of sapphire wash occur on the south side of Retreat Creek, a few miles above its junction with Policeman Creek. Some fine stones have been picked up on the surface, but prospecting has shown that the stones generally are too small for miners to pay much attention to them. These deposits are the lowest and the most easterly on the field, and, being near the level of Retreat Creek, are surrounded by recent alluvium. The accumulation of this alluvium would indicate their being probably of greater extent than what is apparent from the surface. This portion of the area examined appears to be subject to inundation, so that similar deposits—such as they are—may be completely covered by the alluvium brought down by the creek.

Further up Retreat Creek, on the northern side, there is an area of sapphire-bearing country about four miles long, extending from one mile east of the old telegraph line to near Mount Bullock. (*See* Map 2.) On these deposits more work, on the whole, has been carried out than on any others in the district.

To the east and west of Ruby Hill (*see* Map 2), and also on the top of it, the wash varies in thickness. In some of the claims the wash is several feet thick, examples of which are to be seen on the claim of Mr. Newsome and that of Mr. McInnes. The rock boulders and pebbles in the wash include several varieties of "billy," red and brown jasper, basalt, hornblende rock, decomposed slate, indurated slate, sandstone, quartz, and diorite, whilst amongst the smaller pebbles are found fibrous hornblende, magnesite ("white clinker"), tourmaline, topaz, pleonaste, rock crystal, and several varieties of chalcedony.

The bottom of the wash is a decomposed slate, forming a reddish clay, while the surface is either a reddish clayey gravel or black soil. On Mr. Newsome's claim, several rubies have been found, some of which are banded with blue sapphire (*see* Plate 7, Fig. 2), but compared to the blue, green, and yellow sapphires, they may be considered exceedingly rare stones.

At Mr. Innes' claim the wash is very deep, and some trouble is caused by the very heavy boulders which it contains. Some angular prices of chalcedony and jasper found in this claim have been shed from the outcrop of an older formation in the locality. Among the heavy boulders in this claim, in rather a fine wash, two fine yellow sapphires, weighing nearly fifty carats each, were unearthed.

Many of the other claims here, of which Mr. Godlipp's might be mentioned, have produced some fine stones, and this portion of the field for this reason has always been looked upon with favour by the miners of experience.

At the Bessie Workings (*see* Map 2) the wash is very similar to those last mentioned, but the bottom is composed of slate and hornblende rock, both much decomposed in places. The excavations at the time of the inspection, which were being worked by C. Thomas and party, showed indications that the richer portions of them were about exhausted. The hill, however, has not been worked all over the surface, so that other equally rich patches might be found not far away.

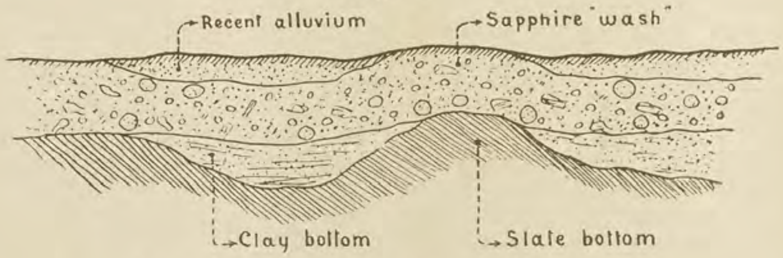
The sapphires found in this length of four miles are blue, green, yellow, and parti-coloured. Blues are generally dark, but occasionally light blues are found, while the green stones, particularly in light shades, are very fine gemstones when free from flaws. Corundum is a usual accompaniment of the good stones, but is worth very little at the present prices, and so is not paid attention to. Pyrope garnet is found as small pebbles, and zircons in several shades of colour are not rare. Some fine hyacinths, a variety of the zircon, are also found at times.

The recent alluvial of Retreat Creek separates the Bessie Workings from others further south, and also from those of Hunt's and Poverty Hill.

At Hunt's Claim the work has been carried on in a systematic manner, and water close at hand has been conserved for washing purposes. The wash is shallow, averaging one foot in thickness, and rests on a bottom of slate or clay. Some of the wash contains ironstone and angular quartz pebbles, but otherwise is similar to that lower down Retreat Creek. One portion, however, can hardly be considered an alluvial deposit, being nearly all composed of disintegrated portions of the slate which forms the bottom.

The sapphires found in Hunt's Claim comprise some large blue stones, and others of a beautiful light yellowish-green. Zircons, garnets, and amethysts are found here occasionally, and pleonaste is very common. Fig. 6 represents a section of the wash at Hunt's Claim, and shows the wash to rest partly on the slate and partly on a clay.

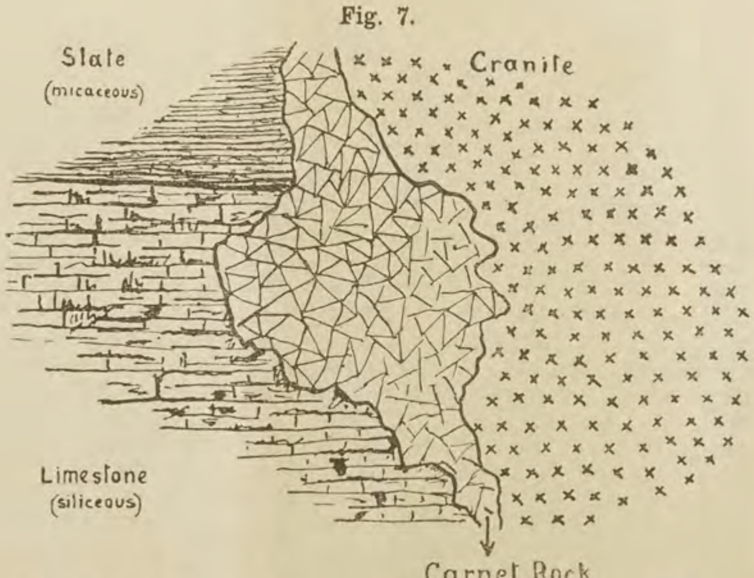
Fig. 6.



Section of Sapphire Wash at Hunt's Claim.

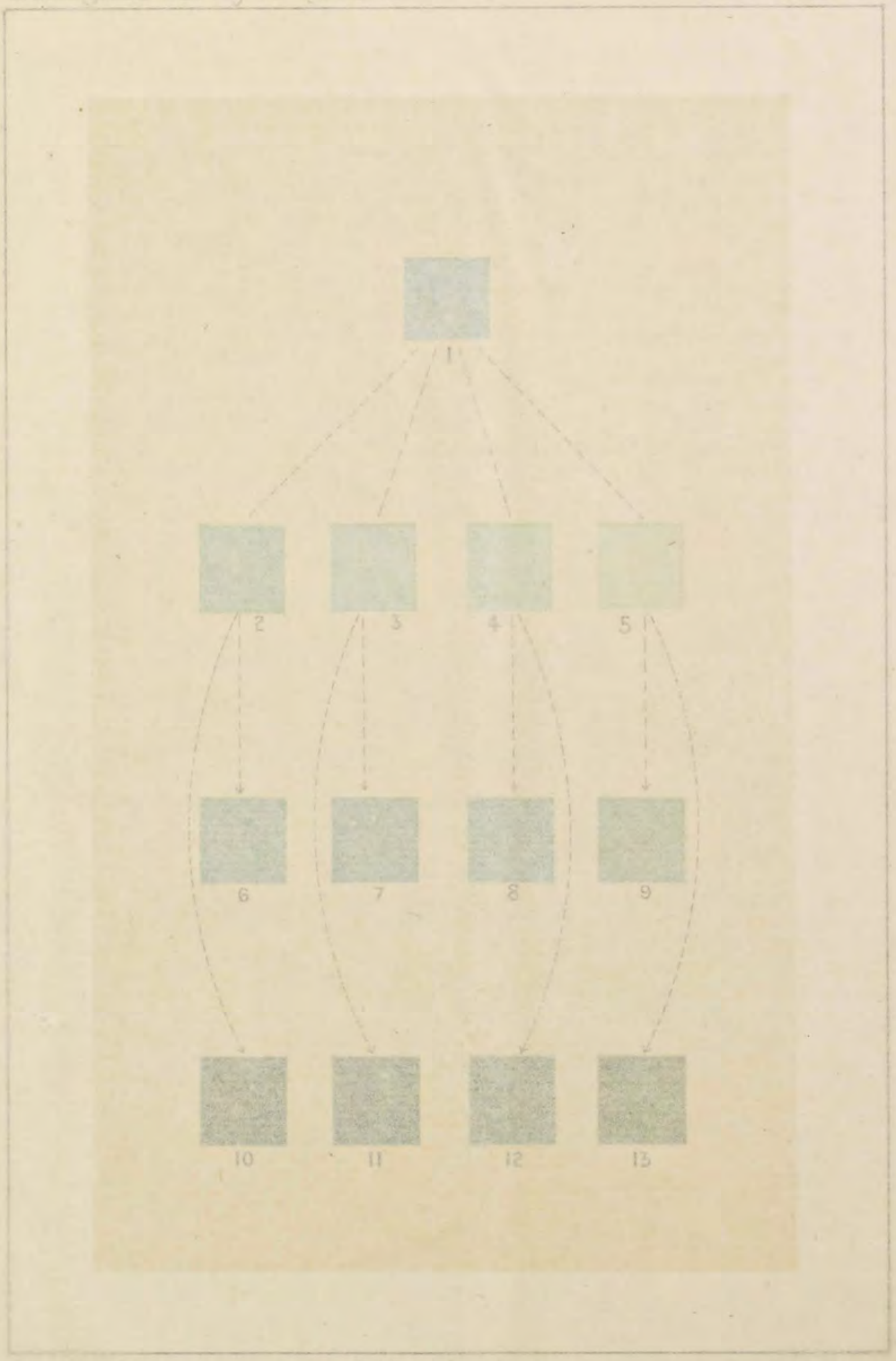
At Poverty Hill the bedrock is partly granite and partly micaceous slate with interbedded limestone. At the junction of the granite and limestone a massive garnet rock occurs with epidote. The garnet is crystallised in part, and the epidote, as well as being in veins, occurs as nests of fine accicular crystals in the interstices between garnet crystals, a feature showing the epidote to have been formed subsequent to the garnet. Fig. 7 shows the general position of these rocks on Poverty Hill.

Fig. 7.



Garnet Rock at the Contact of Granite and Limestone, &c., Poverty Hill.

Geological Survey of Queensland Plate IV



Diagram,

Showing the effect of Pleochroism in the Cutting of Anakie Blue Sapphires.

[illegible] while the surface is either a [illegible] been found, some of [illegible] blue, green, and yellow [illegible]

[illegible] by the very heavy [illegible] in this claim have been [illegible] boulders in this claim, [illegible] were unearthed.

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[illegible] last mentioned, but the [illegible] decomposed in places. The excavations at the [illegible] showed indications that the [illegible] been worked all over the [illegible]

[illegible] and parti-coloured. Blues [illegible] green stones, particularly in light [illegible] accompaniment of the good [illegible] attention to. Pyrope garnet is [illegible] Some fine hyacinths, a [illegible]

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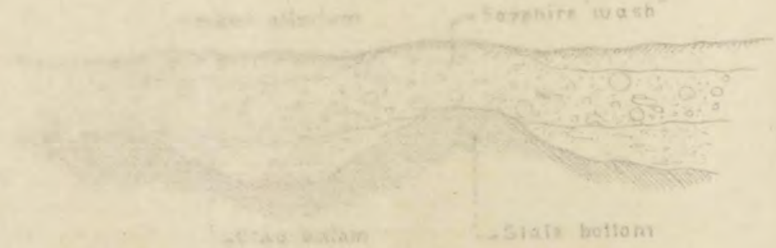
[illegible] manner, and water close at hand has [illegible] one foot in thickness, and rests on [illegible] angular quartz pebbles, but other- [illegible] however, can hardly be considered an [illegible] portions of the slate which forms the bottom. [illegible] and others of a beautiful [illegible] occasionally, and pleonaste is very [illegible] Hunt's Claim, and shows the wash to rest partly on [illegible]

Fig. 6.

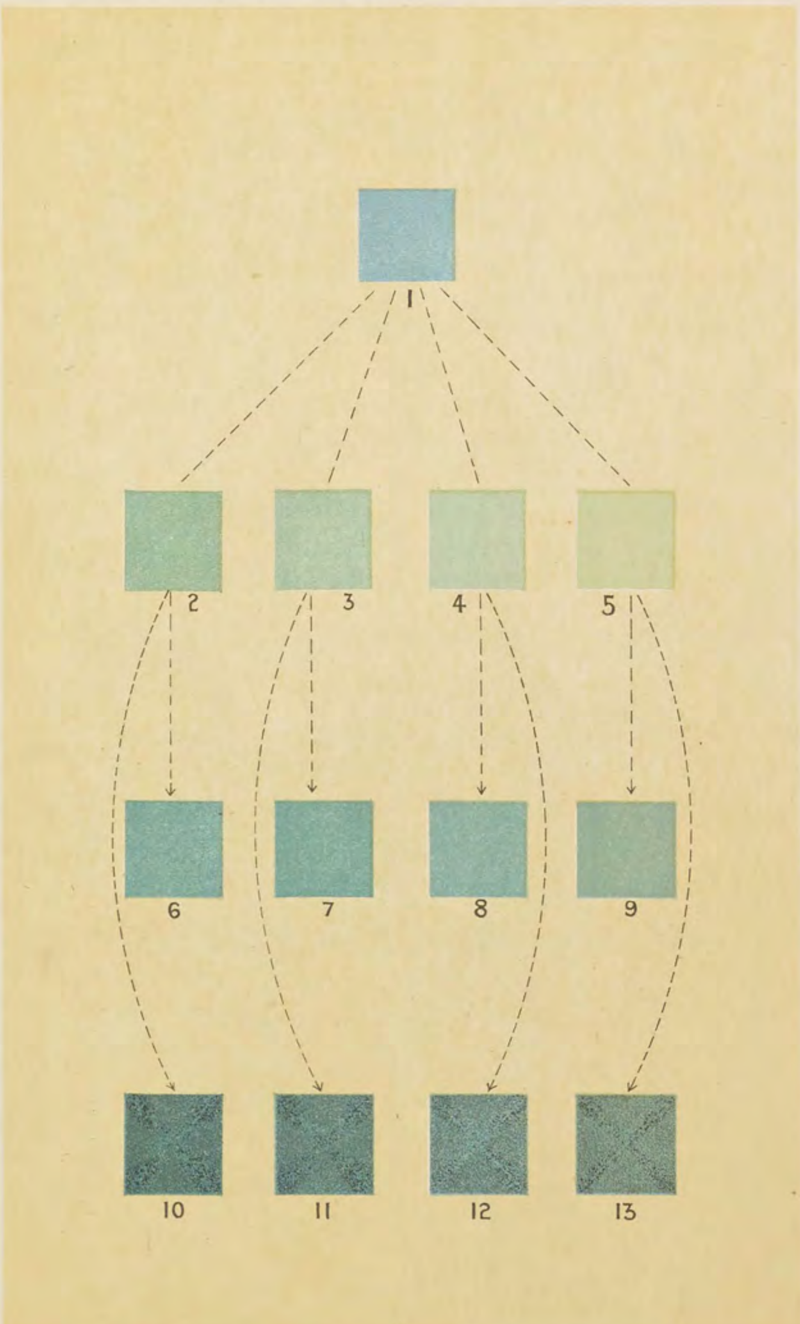


Section of Sapphire Wash at Hunt's Claim.

At Poverty Hill the bedrock is partly granite and partly micaceous slate with interbedded limestone. At the junction of the granite and limestone a massive garnet rock occurs with epidote. The garnet is crystalline in part, and the epidote, as well as being in veins, occurs as nests of fine acicular crystals in the interstices between garnet crystals, a feature showing the epidote to have been formed subsequently to the garnet. Fig. 7 shows the general position of these rocks on Poverty Hill.

Fig. 7.

Garnet Rock at the Contact of Granite and Limestone, &c., Poverty Hill.



B. DUNSTAN DEL. Gov't Printing Office, Brisbane. H. W. FOX LITH.

Diagram

Showing the effect of Pleochroism in the Cutting of Anakie Blue Sapphires.

The sapphire wash is very much like that at Hunt's Claim, but the disintegrated slate is not so prevalent. The sapphires are blue, green, parti-coloured, and occasionally yellow. Some of the green stones are large, and very suitable for cutting, but the colour of the blues are generally too deep.

To the north-west of Poverty Hill, at the Withersfield Sapphire Syndicate's Reward Claim, between Retreat Creek and Sheep Station Creek, there is another sapphire-bearing deposit. The wash rests on a bedrock of slates and schists, and forms the crown of a ridge crossing and extending both easterly and westerly outside the area of the claim.

The wash is remarkable for the large masses of "billy" it contains, a reference to which has previously been made. The "billy" in this locality varies considerably in colour and texture, some being white and fine-grained, some coarse and dark, and others containing large rounded pebbles. Pebbles of basalt, quartz, and red and yellow jasper are also to be found in the wash.

Some very fine gemstones, it is said, have been taken off this mine, and undoubtedly a large amount of pioneering work in the sapphire industry has been carried out by those who are or have been associated with it. Where the wash occurs the sapphires must once have been confined to a channel with slopes leading down to it, and while the hills existing at that time have entirely disappeared and depressions formed instead, what were once the lower parts now form the sapphire ridges. The diagrams on Pl. 9 show how these changes have been brought about.

The wash to some extent has become scattered by weathering agencies, but still the main portions are to be found on the top of the ridge. As a guide to future operations in this locality it may be stated that results cannot be expected to be good in the gullies or spurs, except where they just lead off from the main ridge.

On the Reward Claim, and in the neighbourhood, crystallised corundum has been found in perhaps greater quantities than on any other part of Retreat Creek, and some of the pieces found weighed more than a pound, a very unusual weight on the Anakie Field. Recently a large yellow sapphire was obtained in a rivulet close to the edge of the wash on the ridge, which, after cutting, weighed thirty-three carats.

Both on the eastern and western sides of the Reward Claim a number of miners have been obtaining some fine sapphires and also a few hyacinths of perfect colour.

The Freehold Claim of the same firm is situated about a mile to the west of the Reward Claim (*see* Map 2), but at present is not being worked. From the character of the wash it is supposed that at one time it was connected with the deposits at the Reward Claim, although older formations are now exposed between them.

In describing the sapphire deposits further west, a perusal of both Maps 1 and 2 will show the sapphire wash to be broken up into small patches, and that these patches occur near Washpool Creek as well as near Retreat Creek. At Keilambete Station sapphires have been found about the homestead, but no systematic prospecting work has been undertaken.

Near the heads of Washpool Creek, and also near the junction of Argyle and Retreat Creeks, the sapphire deposits have been worked, but no information concerning the stones found is available, it being some years since the place was abandoned. However, they partake of the general character and appearance of the sapphire deposits lower down Retreat Creek.

Sheep Station Creek is a branch of Retreat Creek, having its source at Mount Leura. Iguana Flat, a locality where there is a large area of sapphire wash, is drained by two watercourses falling into Sheep Station Creek on its northern side at Reed's Waterholes. The sapphire deposits occurring at Iguana Flat, although on the fall of Sheep Station Creek, do not seem to have any connection with those of Retreat Creek, so striking is the difference in the stones found in the two places; neither do they resemble the stones of Policeman Creek, with which, from the trend of the sapphire belt, they appear to have some connection.

The wash of Iguana Flat is generally very clayey, and is often several feet in thickness, and extends very irregularly over a large area. In some of the workings a black soil covering has to be removed before the wash is reached, and frequently on the surface there is nothing to indicate the presence of sapphires, or even sapphire wash.

At this locality, a few weeks before the inspection of this part of the district, some Clermont gold-miners started work. From their previous experience at Clermont, that alluvial gold sometimes occurred below black soil, they supposed that sapphires might be found under similar conditions, but against the advice of experienced sapphire miners they sank through the black soil to prospect, and were rewarded by finding some of the stones. This was quite a new although, naturally, not an unexpected development, as black soil occurs in so many places around the sapphire wash, and is also of more recent formation.

The rock boulders and pebbles occurring with the sapphires on Iguana Flat are limited almost entirely to "billy," this rock comprising about ninety per cent. of the whole, the rest consisting of basalt, quartz, and ironstone. The bottom is a clay, with granite and syenite as a bedrock.

The minerals associated with the sapphires are similar to those of Retreat Creek, but generally are of larger size. The sapphires themselves are characterised by their large size, small stones being in less proportion than the large ones, and frequently clear stones are contained in the interior of coarse corundum crystals.

When miners who have had little experience in this class of mining obtain these large pieces of corundum, they generally place a high value on them, but only a small proportion of good material is found in the centre of them.

(*b*) Policeman Creek.

On the south side of Policeman Creek a large area of sapphire wash occupies the rising ground near the bank, but without touching the present channel. The workings are mostly on the western and central portions, the easterly lower end not containing sufficient stones of marketable size to make the working of it remunerative.

On the extreme western end the claim of Mr. Halliday is situated, and close to it is that of Mr. McCrystal, while more towards the centre, on the eastern side of the north and south dividing fence, are several other claims, of which Mr. Lidstone's is the most important. In McCrystal's Claim a diamond was found at the time of the writer's inspection of the field, reference to which will be made in a subsequent chapter.

The bottom of the wash consists of slates and schists which, more or less, are ferruginous and decomposed into reddish clay. The wash consists of abundance of boulders of white "billy," ironstone, and quartz, with small pebbles of basalt, aventurine quartz, greenish quartzite, fibrous hornblende, and pleonaste. The sapphires found are blue, yellow, green, and parti-coloured, the blues predominating. Policeman Creek "blues" are considered the best blue sapphires on the fields.

On the north side of Policeman Creek there are deposits, which at one time were probably connected with those on the south side. The principal claims are around the "Tempest" workings (*see* Map 2). The "wash" extends both to the east and west of these workings, but it has not been prospected to any extent.

The wash on the north side is generally clayey, but sometimes is a whitish marl containing several per cent. of carbonate of lime and magnesia irregularly mixed with black clay. The associated minerals are pleonaste, zircon, titanic iron, and rock crystal, the former mineral being quite common. Further up on this side of Policeman Creek the sapphire deposits continue for some distance, and then cross to the south side, where they rise up on the watershed to connect with the deposits at Iguana Flat. Very little work is in progress on the upper portion of Policeman Creek, but there are a number of old workings showing that this part has been previously prospected.

From Iguana Flat, where the sapphires are large, to the lower end of Policeman Creek, there is a gradual diminution in the size of the stones, from which it might be assumed that Policeman Creek stones have come from the direction of Iguana Flat—a theory, however, which there is objection to, as it is generally admitted the blue stones at Iguana Flat are not of such a good quality as those at Policeman Creek.

(*c*) Central Creek.

Very little is known of the sapphire deposits existing on the western side of Central Creek. Their position and area has been fixed approximately (*see* Map 1), and enough was observed from a rapid inspection to show that immense bodies of wash, forming whole hills and ridges, can be traced continuously for miles. What the ultimate results will be when they are prospected it is impossible to say, as they might be very poor in sapphires or they might be exceedingly rich.

On the surface, wherever inspected, pieces of corundum and pleonaste, and occasional fragments of sapphires of a light green colour were picked up, and from a cursory inspection many favourable-looking spots were noticed for prospecting operations. No indication could be seen of any mining work, so that if there had been some carried on in the past it must have been confined to simple "surface-picking." The creek is twenty-seven miles north-west direct from the Anakie Railway Station, and by the road is about thirty miles, so it is not surprising that more attention has not been paid to it, especially as the Retreat Creek and Policeman Creek deposits are so much closer to the railway line.

The sapphires generally found are shades of green, some of the lighter being very beautiful, while blues in all shades are not so common. Corundum, pleonaste, and titanic iron are common, but zircons were not observed at all, although possibly occurring in some of the deposits.

The western sapphire deposits evidently are more uniform in their occurrence than those on the eastern fields. They contain heavy boulders and also sandstone pebbles derived from the Drummond Beds higher up the stream. Pebbles of "billy" are very seldom seen. Granite is to be observed all over this part of the district, and evidently is the rock on which the deposits have been laid down.

(*d*) Tomahawk Creek.

The sapphire deposits on Tomahawk Creek are the most extensive in the whole district. They are in places a mile in width and several miles in length, extending from Mount Hoy to below the junction of Tomahawk and Central Creeks (*see* Map 1). The whole of some of the ridges separating Tomahawk Creek from Serpentine Creek are composed entirely of wash, so that the deposits must be of great thickness. These huge deposits have been prospected in places by sinking shallow trenches, but the area so prospected is exceedingly small when compared to its vast extent. The top end of the Tomahawk deposits, near the foot of Mount Hoy, are the highest in the district, being 1,400 feet above sea-level, and nearly 600 feet above the sapphire deposits at the lower end of Retreat Creek.

The trend of the wash from Mount Hoy is towards the north, although there is a small patch of about two miles S.S.E. of the mountain, on what is known as the Ten-mile Gully, one of the heads of Retreat Creek. This deposit has no present connection with those of Mount Hoy, but its presence here indicates the possibility of the deposits of Mount Hoy and Retreat Creek being connected at some previous time.

In trending towards the north from Mount Hoy, the sapphire deposits seem to have split into two channels, one going due north for a short distance, then bending away slightly to the east and crossing Koski's Creek. The other channel from Mount Hoy trends north-easterly down and across Koski's Creek towards Mount Newsome. A break in the deposits occurs here, but they are continued again on the northern side of Mount Newsome, and, after winding about on the eastern side of Koski's Creek, join the other branch a little lower down.

From where the two branches join no break lower down was observed in the deposits. The lower end of the deposits occupy, as one belt, the ridges between the Serpentine on the east side and Koski's Creek and Tomahawk Creek on the west, crosses the latter creek just above its junction with the Serpentine, and then trending north-westerly crosses Central Creek about a mile above its junction with Tomahawk Creek.

The total distance along which the deposits are found from Mount Hoy to Central and Tomahawk Creek junction is altogether about fifteen miles. Further than this the deposits have not been traced. It is extremely improbable, however, that the deposits do not occur still further north, and on the information supplied by Mr. H. Monk, who knows this part of the district very well, sapphires have often been found by station employees when mustering cattle in the neighbourhood of Bevandale, an out-station of Peak Vale.

Geological Survey of Queensland Plate V

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CUT GEMSTONES, ANAKIE

On the [illegible] the claim of Mr. Halliday is situated, and close to it is that of Mr. McCrystal, while [illegible] centre, on the eastern side of the north and south dividing fence, are several other claims, of which Mr. [illegible]'s is the most important. In McCrystal's Claim a diamond was found at the time of the writer's inspection of the field, reference to which will be made in a subsequent chapter.

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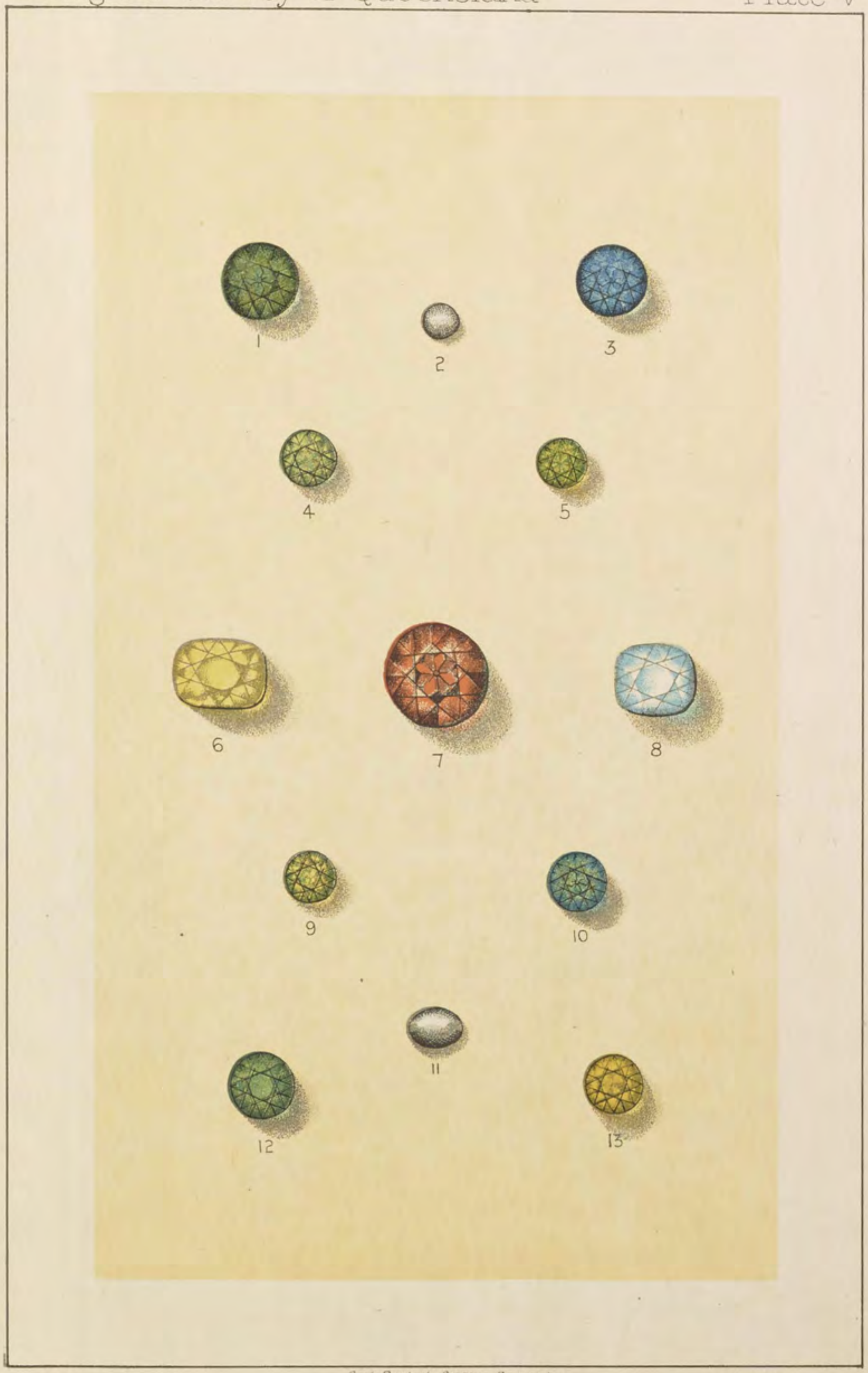
Geological Survey of Queensland Plate V



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CUT GEMSTONES, ANAKIE.

Over this large area no attempt could be made to determine the more favourable localities for prospecting operations, but wherever inspected the mineral pleonaste, the persistent associate of the sapphires, was to be seen, while occasionally corundum and fine green sapphires were found. The wash is similar to that of Central Creek in every respect, and also the same bottom of granite formation is to be observed except near Mount Hoy, where the wash evidently rests on the sandstones and shales of the Drummond Beds.

The colour of the sapphires found on Koski's Creek and Tomahawk Creek are of blue, green, and yellow shades, but the green stones are the more numerous. Some of the green stones are so finely coloured that they have become recognised amongst the miners on the fields as the standard of excellence as "Tomahawk Greens."

(*e*) Smaller Fields.

Boot and Kettle Creek.—Several patches of sapphire wash occur on this creek, which is to the north of Policeman Creek, but they are not so extensive as those on Policeman Creek or Retreat Creek. The patches of wash are said to be small, and the sapphires which they contain also are small, and for both reasons do not offer much attraction to the gem miner. Some good green stones have been found, but the blues generally are of inferior quality. Pleonaste and zircon are present in the wash as small pebbles, and billy and basalt boulders are common.

Borilla.—A small area of sapphire wash occurs on the northern side of the railway line, about a couple of miles north-easterly from Borilla Railway Station. The wash resembles that of Retreat Creek. Evidently the returns by the prospectors here have been unremunerative, as the place is not being worked at the present time.

Argyle Creek.—Concerning this locality little is known, and those who have been prospecting it have abandoned it because, it is said, the stones found are mostly yellow. On this creek a fine yellow stone was picked up weighing twenty-two carats.

Woodbine.—The position of this locality is not shown on the accompanying maps. It is situated at the 213½-mile peg on the railway line, and the wash is in the railway ballast quarries. The stones are said to be good although small, but they are not in sufficient numbers to pay for their extraction.

Glendariwell.—Stones have been found in several places along the southern side of the railway line, in the vicinity of this station, but those found up to the present show that they are too small to be worth mining for.

Llandeillo.—At this place, which is on the Clermont-Anakie Road, being about twenty-eight miles directly north-north-east of Anakie, small sapphires were found at an old cattle yard between McKean's and Miller's selections. The attention of Mr. Godlipp was drawn to them, first by the presence of billy, the "sapphire boulder," but so far as prospecting has shown they are by no means numerous.

6.—METHODS OF TREATING SAPPHIRE WASH-DIRT.

For convenience of reference, the conditions under which the sapphires occur and the methods of treatment according to those conditions have been placed in a tabular form.

The table does not show all possible methods of treatment, as many of the miners work only with an ordinary hand sieve, and when the ground is too damp for dry-sieving they suspend operations until the conditions are again favourable. This practice has been found to answer well enough in some of the workings, as the wash when dry will pay to treat dry, but will not pay to cart to water.

When hand-picking is practised, it has been found more profitable to break up the clayey wash and pick the stones out by hand, rather than to cart it to water. Another reason why the dry methods are adopted even when the wet methods would be far more suitable, is that the miners have not horses and carts to take the wash to the creeks, wells, or waterholes.

Methods of Treating Sapphire-Bearing Wash-dirt.

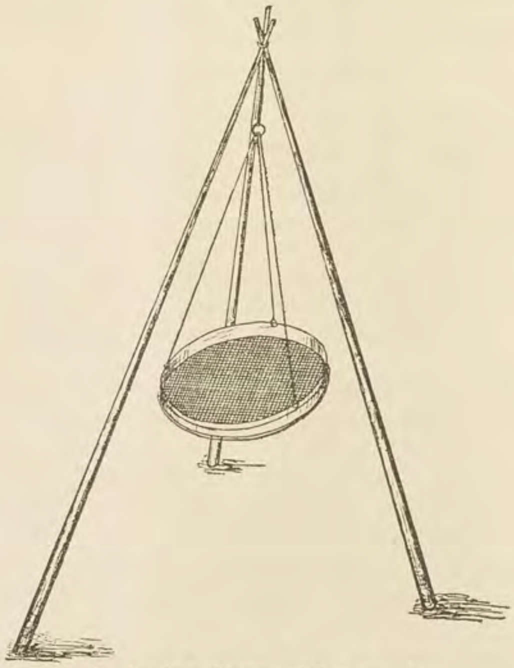
Condition.	Treatment.
If sapphires are small and water scarce—	
1. Wash loose and dry	Suitable for "screening" and "dry-sieving" or "dry-jigging."
2. Wash loose and damp	Suitable for "wet-jigging" or "tomming."
3. Wash clayey	Necessary to "puddle" before "wet-jigging."
If sapphires are large and water scarce... ...	Hand-picking all the wash, including all the clayey portions.
With a good water supply...	Working all the wash by one or more of the processes of "puddling," "wet-jigging," or "tomming," with or without screening.
If sapphires occur on the natural surface of wash, or wash turned over to expose fresh portions of it	Hand-picking, or "specking" during rainy weather.

Appliances.

The equipment of a gem-digger is not a very elaborate one when prospecting new ground, and resembles that of a gold-digger, except that a sieve is used instead of a prospecting dish.

The sieve used is generally of a circular shape, having a wooden frame and a wire screen bottom of a mesh about $\frac{1}{8}$ or $\frac{3}{16}$-inch, according to the size of the sapphires expected to be found. Heavy stones in the wash are picked out by hand, and those of about an inch in diameter are removed by a coarse top screen over the sieve. Frequently this top screen is dispensed with.

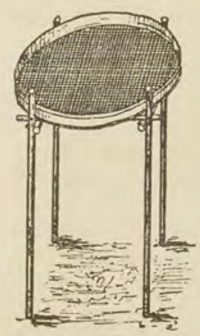
Fig. 8.



Swinging Sieve with Tripod.

Instead of circular sieves others of square shape are used, having either a woven wire bottom or one of perforated sheet iron. A tripod is used by some miners from which to suspend the sieve *(see* Fig. 8), while others prefer a stand of two or four slender upright pieces of wood on which the sieve is placed and shaken, the laths of wood acting as springs, as in Fig. 9.

Fig. 9.



Sieve on Four Spring Battens.

The dry-jigger is an improvement on the sieve, being a square wooden frame about four feet long and two feet wide. It is set up about three feet from the ground on the ends of four flat upright springs made of brigalow wood. (*See* Plates 8 and 10.) The bottom is a screen of coarse wire of $\frac{1}{8}$ or $\frac{3}{16}$ inch mesh.

The dry-jigger is modified by having the box suspended from a framework instead of resting on springs, a suggestion of Mr. Logan of the sapphire mines. This arrangement produces an easy swinging motion, convertible into a short sudden one by the operator, but with the spring-jigger the same sharp motion is produced automatically by the action of the springs.

If the wash contains a large number of pebbles it is sometimes thrown on to an ordinary gravel screen to remove them before jigging. The gravel screen removes the coarsest material, the jigger removing the finest, while the intermediate grade of stuff is that in which the sapphires are looked for.

In looking for the stones in the sieves and jiggers after the fine material has been removed the wash is simply turned over by hand and the sapphires picked out as they are found. When no water is used at all, and the stones more or less coated with clay or iron oxides, it would seem hardly possible to prevent considerable loss in the operations. The miners, however, think otherwise.

In the wet methods of treatment the sieves and jiggers used are the same as for dry treatment, but in addition a table of bark or sheet-iron is usually set up close by, on which the stuff is thrown. As all the wash is wet the sorting is done more expeditiously, and apparently with less chance of losing any of the stones than in the dry way. (*See* Plates 8 and 10.)

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Corundum Crystals, Anakie.

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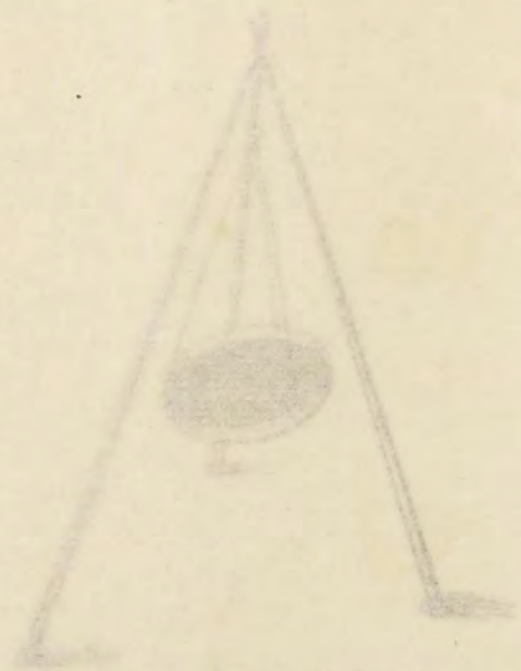

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CORUNDUM CRYSTALS, ANAKIE.

A trough is always used in wet-jigging to soak the wash, and also to puddle any clay which may be present, both operations effecting a considerable saving of labour and water. The material of which the troughs is made are various. Some are made of galvanized iron, others of bark or of slabs of wood, but generally they are made in one piece from a hollow tree.

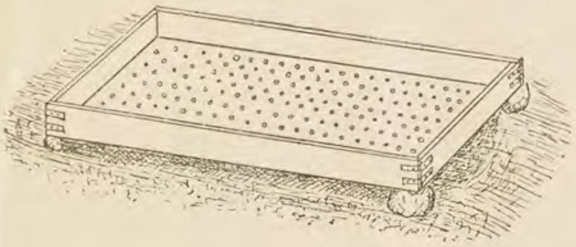
In making a trough of the latter kind, a log of about eighteen inches or two feet in diameter is sawn to the length required (about ten or twelve feet) and one side cut away. If not sufficiently hollowed it is made so, first by burning away a portion by making a fire in the interior, and afterwards chipping it into proper shape with an axe or adze. The two ends are closed by boards, in one of which a slide is made to allow of cleaning out when required. The diameter of the trough should not be increased or decreased much outside the limits mentioned, otherwise the manipulation of the wash will not be convenient. Plate 8, Figs. *b*, *f*, shows two such troughs.

Instead of this kind of trough a square-shaped one is sometimes used. It is built of slabs, and is about four feet square and eight inches deep (*see* Plate 10 at *b*), and sunk into the ground.

The sorting table is placed just below the level and at the end of the wet-jigger, one end of which is left open. After washing all the material in the jigger it is scraped on to the sorting table where it is more conveniently examined for sapphires, &c. (*See* Plates 8 and 11.)

Working with the old-fashioned "tom" is practised by several of the sapphire miners, and undoubtedly produces good results. As used on the Anakie Fields it is a wooden box about six feet long, three feet wide, and about eight inches deep, and having a perforated sheet-iron bottom. (*See* Fig. 10.)

Fig. 10.



A "Tom" as Used in Sapphire Washing.

The "tom" is placed in an inclined position near the edge of a waterhole or other reservoir, and is filled to about half its capacity with wash-dirt. A small "race" carries the water from the reservoir to the head of the "tom," where it is lifted with a hand bucket and thrown over the wash, which at the same time is being kept stirred up with a shovel by another operator. After being cleaned, the material is not removed for sorting, as this operation is performed on the bottom of the "tom" and not on a table.

All these appliances are very simple and easily constructed, and when worked by small parties of miners will answer all purposes. Sluice-boxes are not used on the fields on account of the insufficient supply of water during the greater part of the year, but there is no doubt whatever that sluices could be arranged to save the sapphires if a sufficient supply of water could be obtained by well-sinking or by conserving in dams. Sluices would have the additional advantage of saving any gold in the sapphire-wash, which at present passes away in the tailings.

7.—MINERALOGICAL NOTES.

(*a*) SAPPHIRES.

Crystalline Form, Cleavage, Twinning, Inclusions, Specific Gravity, and Hardness.

The hexagonal pyramid with its modification is common, but the prism is comparatively rare. The simple barrel-shaped form (Pl. 6, Fig. 1) was observed with and without any hemihedral truncating faces. A crystal having two opposite faces cut out has the remaining four largely developed, and gives a lozenge shape to the basal section (Pl. 6, Fig. 2).

Very acute rhombohedrons with terminal basal planes occur (Pl. 6, Fig. 6), also pyramids with curved faces (Pl. 1, Fig. 2), and also small rhombohedrons developed on a large basal plane (Pl. 1, Figs. 5, 5*a*). Variations in the building up of the form of crystals are shown in several specimens. One example (Pl. 6, Fig. 4) shows a primary (?) pyramid (*a*) with a short terminal pyramid (*b*) without any development of a basal plane, but the crystal has continued the growth (*c*) from the primary (?) pyramid and overwhelmed the terminal one. Another development, starting at the base (?) of the primary pyramid has formed over this a covering pyramid (*d*), also with a terminal pyramid (*e*). Finally, the pyramid (*d*) has continued its growth (*f*) and formed a terminal pyramid (*g*) to complete the present outline of the crystal. The sketch shows the crystal in section along the principal axis. The above stages in the building up of a crystal suggests a sort of "cone in cone" development. Sometimes in a crystal there are bands of a dark colour alternating with those of a light colour along the basal plane as in Pl. 7, Figs. 4, 5, 7, 16*a*.

Some crystals, evidently, have had only a pyramidal growth, but are remarkable for the apex being of a different colour to the other portion of the crystal (Pl. 7, Fig. 11). This crystal suggests that the growth has been terminal and not lateral. Another specimen shows a secondary lateral development on one prism face only, the first and second development being coloured yellow and blue respectively (Pl. 7, Figs. 9, 9*a*), while two other crystals show acute rhombohedrons of one colour (yellow) enclosed in a prism of another colour (Pl. 7, Figs. 1, 15).

Basal sections show other peculiarities. Some crystals have single narrow bands on the periphery (Pl. 7, Fig. 3), or a number of alternating light and dark bands as in Pl. 7, Figs. 2, 13, and Pl. 6, Fig. 5. One section shows a partial banding of yellow in an otherwise blue crystal (Pl. 7, Fig. 14), and seems to be a growth of crystal of yellow colour like that represented in Pl. 7, Figs. 9, 9*a*, supplemented by a subsequent lateral envelopment with blue crystal.

A basal terminal plane is divided into three portions (Pl. 6, Fig. 8). From the larger portion the other two are separated by a step formed by the development of a rhombohedral face. The other two smaller portions are also separated from one another by a second step along a second rhombohedral face.

A small basal section shows the hemihedral form of the di-hexagonal pyramid or prism (Pl. 7 Fig. 10), and another similar section shows the effect of rhombohedral crystallization in producing three small dark triangles (Pl. 7, Fig. 6), and a third specimen shows a delicate rhombohedral cloudiness which is serrated in vertical section (Pl. 7, Figs. 15, 15*a*). Fine zonal lines when crossing those resulting from rhombohedral cleavage show the *sagenitic structure* represented on Pl. 2, Fig. 6, when viewed on a basal plane. An oscillation between pyramidal and prismatic growth has taken place on portions of one crystal, producing a terraced effect on the side of it, as shown in Pl. 6, Fig. 3, while a truncation all around from the same cause has produced the effect represented in Pl. 6, Fig. 11.

On Pl. 1, Fig. 3, which diagrammatically represents the basal plane of a crystal of corundum, the emergence or intersection of rhombohedral cleavage planes is indicated by three bars crossing each other at angles of 60°. These bars are comprised of a number of extremely thin parallel cleavage plates, which produce a pearly lustre on the basal cleavage plane. The presence of these bars is supposed to give the "asteria" effect, but this might not be produced from these bars at all. Asteria can be produced by cutting *en cabochon* a stone which has a fine silky zonal banding hexagonal in prismatic section, the rays of which are not apparent in the stone before cutting. The six-rayed corundum is very common all over the field, of which Pl. 2, Figs. 4 and 5, and Pl. 6, Fig. 9, are examples. The arrows in Pl. 1, Fig. 3, indicate the direction of inclination of the rhombohedral cleavages.

Where the basal cleavage faces are very numerous but very thin, and the stone light in colour, the pearly effects of moonstone is produced, and such a stone is suitable for cutting *en cabochon* as an oriental moonstone or cat's-eye. A bronze lustre is frequently observed resulting from the same cause, but in this case the stone is dark-coloured.

In some specimens the basal cleavage is very perfectly developed. Often the cleavage flakes are exceedingly thin, but sometimes the crystal with a perfect cleavage will only separate in thick plates or segments, a character very noticeable in some specimens when they are being polished. In cutting and polishing sapphires the "table" of the stone is made parallel with the basal plane, which is difficult to polish if the stone has a tendency to develop these thin cleavage flakes, but when the cleavage is segmental this difficulty is not experienced. In the former case the difficulty is overcome, it might be stated, by polishing the facet in a direction parallel with the line of the break in the polished surface, or, in other words, at right angles with the direction of the very slight inclination which, from the gem-cutter's error in judgment, the cleavage makes with the facet being polished.

Other peculiarities in the crystalline structure of the sapphires have been observed. In one specimen the increase in the lateral growth of the prism is marked by thin bands of zonal inclusions, some of which also show traces of two rhombohedral cleavages. Along all these planes there is a partial alteration of the crystal, traces of which can be observed on the faces of the prism, as in Pl. 1, Figs. 1, 1*a*.

The rhombohedral cleavage is frequently developed only in two of the planes, and where this is so a kind of "hour-glass structure" is to be observed in basal sections. Such a structure would be as represented in Pl. 2, Fig. 5, with one of the bars omitted.

Penetration twinning has only been observed very rarely. In Pl. 1, Fig. 2, the impression of a small hexagonal crystal is shown on a larger crystal, being a partial penetration-twin, and in some of the waterworn and corroded crystals of corundum traces of penetration twinning have been observed. In the centre of a piece of corundum, showing the three rhombohedral cleavages, a small hexagonal section of very dark crystal was noticed on a polished face, as shown on Pl. 2, Fig. 4. A vertical section of this is shown in Fig. 4*a*.

Massive corundum has not been observed. Large pieces of corundum have been found in several places, but they are portions of crystals which have been more or less waterworn, or previously corroded by molten basalt. It has been proposed to utilise corundum in boring operations, and to even replace diamonds for this purpose. It is only the compact massive corundum which is tough, and the crystalline varieties would be quite unfit for such a purpose in consequence of not having this property, even were there no other objections to it. A parallel may be drawn between the crystalline diamond and the "carbon" or non-crystalline variety of diamond. While the latter, of course, is unequalled in abrading power in a diamond drill, a crystalline diamond would be practically useless. Notwithstanding a previous expression of opinion that Anakie corundum would not be suitable for boring purposes, experiments were made with some of it in one of the Government diamond drills on the Croydon Gold Field, and resulted in a complete failure.

The hardness of some of the Anakie sapphires is variable, and lapidaries have repeatedly stated that the hardness of some specimens is frequently greater than 9 (Moh's scale) and varies even in the one crystal. In slicing with the diamond disc this is specially noticeable, some portions being much more difficult to operate upon than others.

Inclusions in the sapphires are not uncommon and usually are microscopic dust in the form of zonal bands. Fine bodies sprouting out from the zonal bands prove to be magnetite in a dendritic form, and appear to be the result of the alteration of these inclusions. The crystallisation of the magnetite has taken place along four planes, one along the basal cleavage, the other along rhombohedral cleavages.

The colour of the magnetite is from very light brown to dark brown and black. In even a thin section of the crystals the fine delicate films of the mineral can be perceived to overlap one another without touching where they occur between the fine cleavage flakes. Where the overlapping takes place, the mineral is black in transmitted light, but otherwise is very frequently of a pale brown colour. Where the thin plates are being developed along the fine cleavage cracks, their margins are serrated, and where they cross a rhombohedral twinning (cleavage) plane, the mineral at the crossing has not formed, although continued on either side.

In basal section the edges of the magnetite plates in the rhombohedral cleavages, as they cross one another, appear as fine interlacing black lines.

The magnetite also occurs as fine microscopic crystals of normal shape. In several specimens of very deep green sapphire it was observed in dusty masses, and in one crushed specimen it was readily detected both with the blowpipe and magnet.

Geological Survey of Queensland Plate VII

CORUNDUM CRYSTALS, ANAKIE

[illegible] the larger portion the [illegible] face. The other two [illegible] second rhombohedral face.

[illegible] pyramid or prism (Pl. 7 [illegible]) [illegible] in producing three [illegible] [illegible]dral cloudiness which [illegible] crossing those resulting [illegible] Fig. 6, when viewed on [illegible] place on portions of [illegible] while a truncation all [illegible]

[illegible] crystal of corundum, the [illegible] crossing each other [illegible] cleavage plates, which [illegible] supposed to give the [illegible] can be produced by [illegible] zonal banding [illegible] [illegible]matic section, the rays [illegible] is very common all [illegible] Pl. 6, Fig. 9 [illegible] arrows in Pl. 1, Fig. 3, [illegible]

[illegible] stone light in colour, [illegible] *en cabochon* as an [illegible] from the same cause, [illegible]

[illegible] very [illegible] the cleavage flakes are [illegible] with a perfect [illegible] in thick plates or [illegible] specimens [illegible] polished. In cutting and [illegible] is made parallel [illegible] which is difficult to polish [illegible] thin cleavage [illegible] cleavage is segmental this [illegible] the difficulty [illegible] be stated, by polishing [illegible] of the break [illegible] or, in other words, at [illegible] very slight [illegible] gem-cutter's error in [illegible] being polished.

[illegible] crystalline structure [illegible] been observed. In one [illegible] growth of the prism [illegible] of zonal inclusions, [illegible] rhombohedral cleavages. [illegible] planes there is a partial [illegible] which can be observed [illegible] prism, as in Pl. 1, [illegible]

[illegible] frequently developed [illegible] and where this is so [illegible] be observed [illegible] structure would be as [illegible] of the bars [illegible]

[illegible] been observed [illegible] Pl. 1, [illegible] the impression of a [illegible] larger crystal, being a partial [illegible] and in some of the [illegible] corundum [illegible] of penetration twinning have been observed. In the [illegible] the three rhombohedral cleavages [illegible] hexagonal section of [illegible] polished face, as shown on Pl. 2, Fig. [illegible] section of this is [illegible]

[illegible] observed. Large pieces of corundum have been found in several [illegible] which have been [illegible] previously corroded [illegible] to utilise [illegible] and to even replace [illegible] the compact [illegible] which is tough, and the [illegible] for such a purpose [illegible] this property, [illegible] A parallel [illegible] the crystalline diamond [illegible] variety of diamond. [illegible] is unequalled in [illegible] crystalline diamond [illegible] Notwithstanding [illegible] boring purposes, [illegible] the Croydon Gold [illegible]

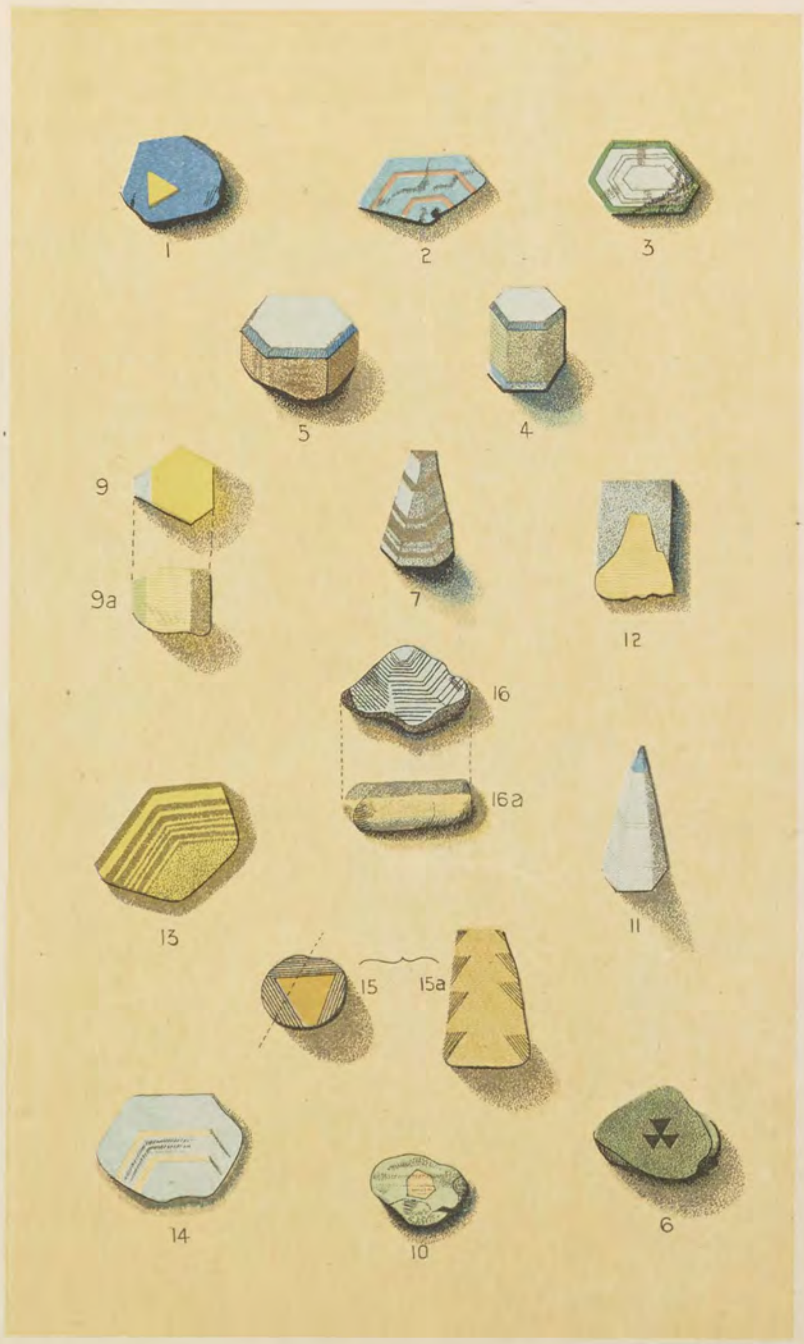
[illegible] repeatedly stated that [illegible] even in the one [illegible] being much more [illegible]

[illegible] dust in the form of [illegible] dendritic form, [illegible] The crystallisation of the [illegible] has [illegible] rhombohedral cleavages.

[illegible] from very light brown to dark brown [illegible] In even a thin [illegible] of the mineral can be perceived [illegible] one another without [illegible] the fine cleavage flakes. Where the [illegible] takes place, the [illegible] very frequently [illegible] brown colour. Where [illegible] along the fine cleavage cracks [illegible] are serrated, and where [illegible] cleavage plane, the mineral [illegible] has not formed, although [illegible]

[illegible] plates in the rhombohedral cleavages, as they cross one [illegible]

[illegible] microscopic crystals of normal shape. In several specimens of [illegible] and in one [illegible] specimen it was readily [illegible]



B. DUNSTAN DEL. GOV^T PRINTING OFFICE, BRISBANE. H.W. FOX LITH.

CORUNDUM CRYSTALS, ANAKIE.

Determinations were made of the specific gravity of the blue, yellow, and green sapphires, and also of large crystals of corundum. The variation ranged from 4·000 to 4·050, no specimens indicating a specific gravity below 4. No perceptible difference could be obtained from the transparent crystals of different colour, or between these and the opaque corundum crystals, the maximum variation of the above values being in crystals of one (blue) colour.

COLOUR AND PLEOCHROISM.

The blue varieties are most abundant at Retreat Creek, Policeman Creek, and other places on the eastern fields of the district; while the green stones, so far as prospecting has indicated up to the present, are common on the western fields of Tomahawk Creek and Central Creek.

The parti-coloured stones are common on all the fields, while the yellow stones are very rare. Shades of blue range from a very light to a very dark blue, but the rich cobalt-blue colour—the corn-flower-blue—has not yet been found. The green shades vary from a very lightly tinted pale green to a deep olivine green. The light green stones having just a perceptible golden tinge are very beautiful, and might be appropriately termed *Oriental chrysoberyl*, while the pure green would be the *Oriental peridot*.

Another variety is the *Oriental topaz*, of both canary and orange-yellow shades, of which some fine specimens have been found. The red variety, the *Oriental ruby*, is very rare, but one specimen examined, although defective in other respects, is decidedly perfect in colour, and was obtained from Mr. Newsome's Claim on Retreat Creek.

Purple tinted stones—the *Oriental amethyst*—are very rare, and only occur as a gradation in the colour of the blue or red stones. They, however, have the true amethyst colour. What has been supposed to be oriental amethyst occurs plentifully on the field, but the examination of a number proved them to be ordinary amethyst, the quartz variety. The oriental cat's-eye has been previously referred to.

These colours may then be considered as making up the following eight varieties :—

Sapphire	Blue
Oriental amethyst	Purple
Oriental ruby...	Red
Oriental peridot	Green
Oriental chrysoberyl	Yellowish green
Oriental topaz	Yellow
Oriental cat's-eye	Smoky
Oriental moonstone	Pearly

An attempt has been made to represent these varieties in colour on Pl. 5, 6, and 7, which show both rough sapphires, corundum, and cut specimens.

The lustre of clear stones is almost adamantine, but in the coarser translucent varieties it is opalescent, bronze, milky, pearly, silky, and smoky. Opaque varieties are usually black, but sometimes brownish-black, dark blue, light blue, and greyish white. No instance was observed of the corundum being opaque green.

Sometimes transparent stones have become opaque by the infiltration of mineral matter along fractures and cleavage planes, and transparent stones are occasionally coloured blood-red in a fracture in the interior by the deposition of a fine film of hematite. When viewed through the film the stone appears of a brilliant red colour, but when looked at side ways, it is not apparent, or only a thin dark streak observable. The presence of this film in, say, a green stone would give a red colour in one direction, while in the other direction the green colour would be observed. One of the miners who had been reading something about sapphires had observed this, and stated that "this was a remarkable instance of dichroism in sapphires." One specimen showing this red central spot is represented on Pl. 6, Fig. 16.

In the deeper coloured sapphires the pleochroism is very marked, but in some of the light yellow and green varieties it is hardly noticeable. In the blue stones the *face-colour* in the direction of the *optic axis* differs very considerably from that at right angles with this axis, a property which has to be considered in the cutting of the stones as gems.

In the Anakie blue sapphires, if the table of the gemstone is cut at right angles with the optic axis, the colour obtained will be a blue face-colour, but if the table is cut parallel with the optic axis, instead of getting the face-colour of the crystal in that direction, that obtained is broken up into what appears to be two axis colours by the prisms formed in the angles between the facets of the stone. As the optic axis is perpendicular to the basal cleavage plane, a stone cut parallel to this plane will show a blue colour, but if cut at an angle with this cleavage plane the nearer it approaches a right angle the greater will be the confusion of both blue and green colours. These effects are illustrated on Pl. 4, and show that blue stones of apparently one shade, when looked at in the direction of the principal axis, may have variations in the colour at right angles with this direction. The effects of cutting such stones in the right direction are shown, and also the effects when cut incorrectly. From this plate it will also be seen that as the face colours of the prism become lighter, the axis colours show less green—a condition which will produce a bright blue when the table is cut parallel to the basal cleavage.

If the face colour of the prism is very dark, even with a bright blue on the basal plane, then when the stone is cut with the table parallel with the basal cleavage the bright blue becomes either a very deep blue or blue-black.

When the table is made at right angles with the basal cleavage plane, even though the stone is nearly colourless in this direction, the blue in the direction of the basal plane will have a darkening effect and the gem will show a confusion of colours. *Therefore, when the basal cleavage plane is made the " table " of the gemstone, the less the colour on the " side " of a crystal the brighter will the " top " colour be after cutting, and the more perfect the gem.*

In green sapphires the face colours are different, and the contrast in the axis-colours is not so marked. In yellow stones there is no appreciable difference in the face colours in either direction, so that so far as colour is concerned no special care is necessary in cutting.

As the question of colour, however, is generally an important one in the cutting of gemstones, a means of recognising the basal plane, when the cleavage is obscure, will be useful to the lapidary, and this is afforded by the *dicroscope*.

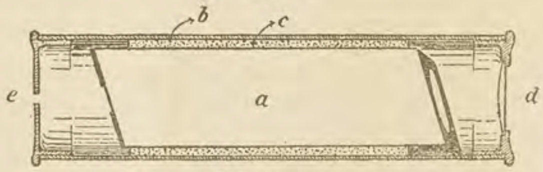
b

Descriptions of this little instrument have been frequently published. A simply constructed dicroscope is made of a cleavage prism of Iceland Spar mounted in a tube, on one end of which is placed a lens, the other end having a small aperture. The spar should be at least an inch long and about ⅜-inch in diameter, each cleavage end of which, without polishing, is finished by cementing on to it, with Canada balsam, a microscopic cover-glass.

The prism must be painted dead-black, mounted in pieces of cork and pushed into the tube without the addition of other prisms. The tube should be about two and a-half inches long and about half an inch in diameter. On one end is mounted a lens of about three inches focus, to allow the specimen examined to be held in the fingers about half an inch away from the aperture, which is about one-sixteenth of an inch or less in diameter. The end of the prism next to the aperture should be all coated black except a small portion in the centre of about three-sixteenths of an inch in diameter, while the other end, near the lens, should be blackened except a centre of about three-eighths of an inch in diameter.

The following sketch will show the instruments as described:—

Fig. 11.



Dicroscope.

a. Iceland Spar. *b*. Tube. *c*. Cork Mounting. *d*. Lens, about three-inch focus. *e*. Aperture.

With this instrument the lapidary can determine the direction of the optic axis of a sapphire by observing, in transmitted light, the position in which the two coloured spots (the double image of the aperture) show no difference of tint when the instrument is rotated between the eye and the specimen under examination. As the basal cleavage plane is at right angles with the optic axis, the portion of the crystal which shows no change of colour, or any other portion parallel to it, should be made the table of the stone.

The rhombohedral cleavage is occasionally present in sapphire crystals, and might be mistaken for the basal cleavage by the gem-cutter, and as the stone should not be cut with the table parallel with the rhombohedral cleavage, the dicroscope can be made use of to determine whether a cleavage face is rhombohedral or basal.

The dicroscope also is used in the discrimination between true sapphires or rubies and imitation stones, as well as for other purposes which need not be mentioned here. Artificial stones show no change of tint with the instrument, no matter in what position they are examined—they are not *pleochroic.*

(*b*) Zircons.

Hyacinth, the variety of zircon, occurs with the sapphires in the alluvial deposits on all the fields. Usually it is found as small grains, of shades varying from brown to deep blood-red, and rarely in crystals sufficiently large or clear enough to be cut as gemstones. The smoky variety of zircon is unknown on the field.

The small colourless zircons found below the basalt at the old Basalt Hill Diggings and Policeman's Knob, previously referred to, have a resemblance to rough diamonds, and have been mistaken for such. They have rounded faces, are brightly polished, and have a brilliant lustre; but their hardness, which is inferior to sapphire, betrays them at once.

The hyacinth in some of its richer shades is very beautiful, and, although softer than sapphires, are much harder than the opal—the so much prized Australian gemstone. Perfect specimens are very rare, but one weighing over an ounce, after the removal of inferior portions, cut into a gem stone weighing fifteen carats. This is shown on Pl. 5, Fig. 7.

The property of altering its colour is noticeable in some of the Anakie hyacinths. Sometimes the colour is changed by the temperature of the body, this having happened with miners who have carried the stones about with them in their pockets. By gradually heating the stone a portion of the colouring is destroyed, so that a stone too deeply coloured for a gem may be made sufficiently light by this means. The heating of the stone sometimes lessens only the depth of the colour, but it will usually alter the colour from red to brown. Heating intensely will destroy all the colour. Slightly heating will sometimes increase the brilliancy of the colour, which returns to its former tint as soon as the stone becomes cold. Should the stone be heated too much it loses this property, and the colour is permanently destroyed.

Exposure to bright sunlight also changes the colour, but experiments have shown that the original colour returns afterwards. One specimen which had been made colourless by heating became slightly coloured by exposure to light. Specimens, however, which have been exposed and subjected to a certain amount of heating at the hands of the lapidary, in cementing them to the holders for the purpose of grinding and polishing, do not appear to lose their colour under ordinary conditions.

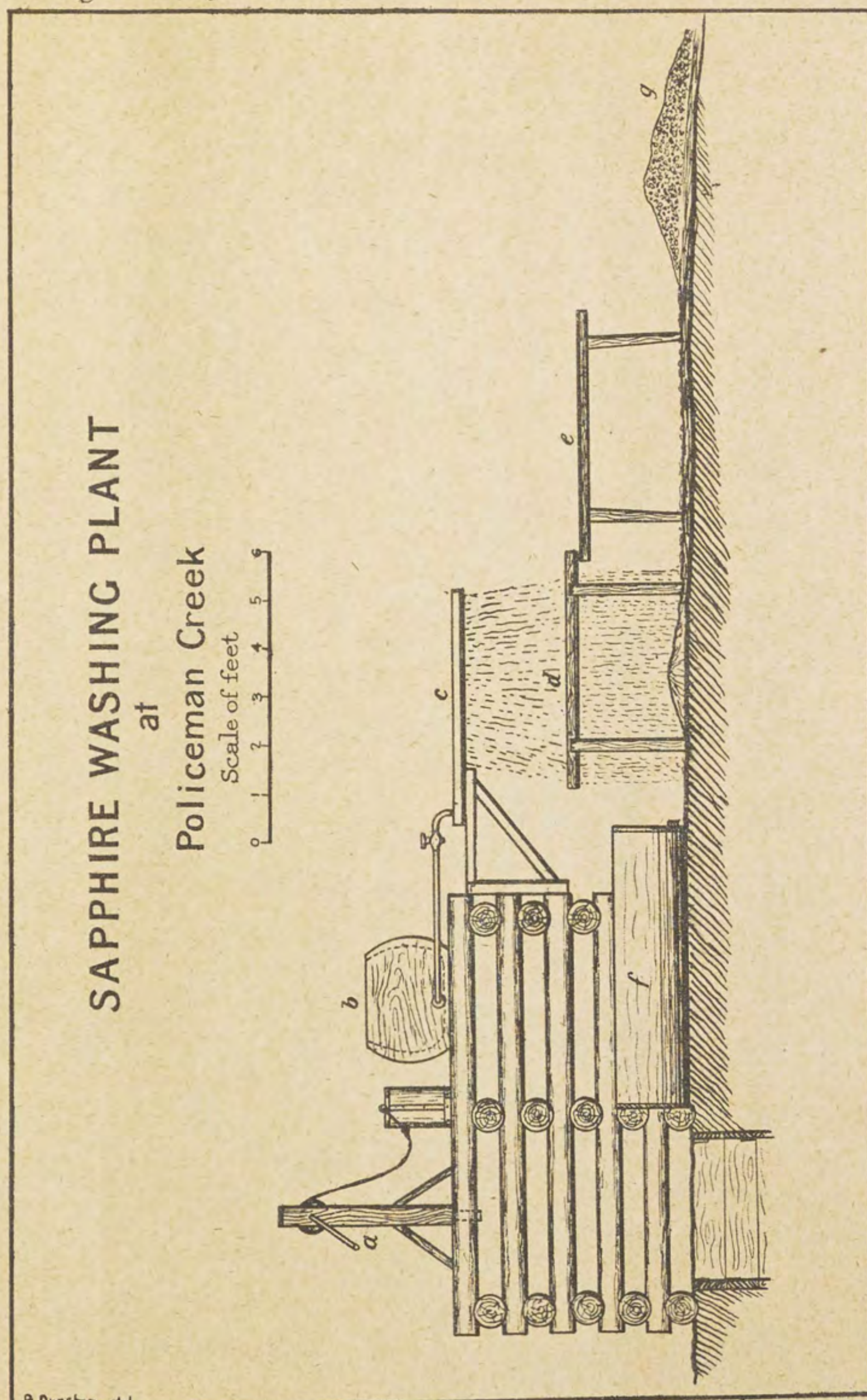
The specific gravity of a number of cut and uncut specimens of hyacinth has been determined, and varies between 4·696 and 4·699, the mean being 4·698.

Pleochroism was only observed in a few thick specimens. The change of colour is slight, and in sections cut for microscopic work is not discernible.

Corrosion of the zircons has previously been referred to. An example is shown on Pl. 3, Fig 5.

(*c*) Pleonaste.

This black variety of spinel is found in great abundance wherever the sapphires occur, and although usually occurring as small grains it is also found in pieces of about an ounce or more in weight. It was observed embedded in the basalts of Policeman Knob, Basalt Hill, Mount Hoy, Mount Newsome and Mount Leura, reference to which has previously been made.


SAPPHIRE WASHING PLANT
at
Policeman Creek
Scale of feet
0 1 2 3 4 5 6
a
b
c
d
e
f
g
B. Dunstan del.

Specimens showing the crystalline form are rare, as they have been subjected to corrosion by the basalt, but Pl. 2, Figs. 2, 2*a*, 7, 7*a*, show two crystals whose outline has been preserved. Corrosion effects are common, of which Pl. 2, Fig. 1, and Pl. 3, Figs. 1, 8 are illustrations.

The mineral invariably is opaque-black, has a conchoidal fracture and a glassy lustre. Frequently it is mistaken for corundum by miners, but corundum has a cleavage, and has a lustre on a basal cleavage plane different to the other part of the crystal, and is much superior in hardness, so no difficulty should be experinced, even without other tests, in distinguishing the two minerals. The red variety of spinel—spinel ruby—occurs in some of the fields, but only three small indifferent specimens were observed.

8.—MINERAL CORROSION BY BASALT MAGMA.

The corrosion of corundum and pleonaste in the basalt has been referred to previously. The specimens of sapphires found in the cap of Mount Hoy show traces of corrosion but none of erosion. Where the sapphire inclusions are in contact with the enclosing basalt, a film has been formed, and portions of this remain adhering to the specimen as a black scaly coating.

In the alluvial deposits sapphires are found showing the effects of corrosion. The broken portion of the crystal in Pl. 1, Fig. 2, shows corrosion marks, and Pl. 1, Figs. 4, 6, are illustrations of the surfaces, other crystals of sapphires showing similar effects.

With pleonaste the effects are more marked. Rarely has the crystal a polished face or sharp angle, while the pitting of the surfaces with holes is quite common. On Mount Leura every block of basalt shows pieces of pleonaste on its surface, either as rounded scaly blebs (Pl. 3, Figs. 3, 4), as irregular pitted grains (Pl. 3, Fig. 8), or as crystals whose outlines are reduced to skeletons (Pl. 3, Fig. 1). Occasionally the crystalline form of the pleonaste has been preserved with only sufficient corrosion to dull its surface. An example of this is shown in Pl. 2, Figs. 7, 7*a*.

Other corroded mineral inclusions in the basalt of Mount Leura are illmenite, of which Pl. 3, Fig. 2, represents a crystal; plagioclase, a section of which is shown in Pl. 3, Fig. 9; hornblende (Pl. 3, Fig. 7), quartz, and olivine. On Mount Hoy similar corroded inclusions are to be observed in abundance.

From the irregularity of the surfaces of some of the sapphire crystals and other minerals it was thought that they may have been allotriomorphic forms. Some crystals have peculiarities which rather bear this out, in showing the form of the crystal to have been modified by some other mineral at the time of its crystallization, but the preponderance of evidence points to corrosion as the cause of the markings.

9.—THE DISCOVERY OF A DIAMOND AT POLICEMAN CREEK.

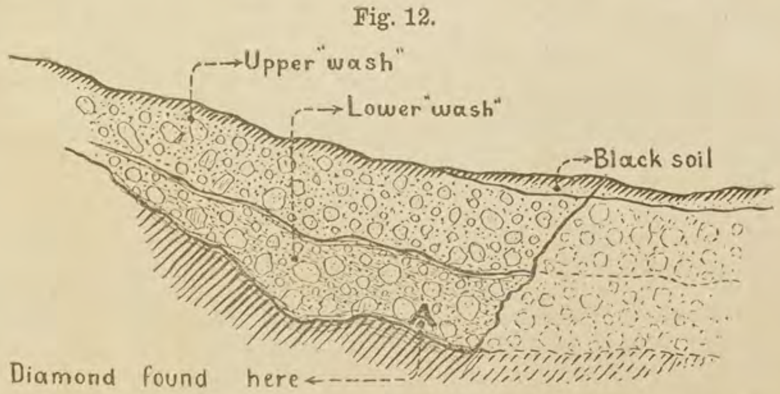
The discovery of a diamond in the sapphire wash was the result of an investigation as to what the miners forwarded to the gem dealers as "white sapphires." Many of the miners have made it a practice to "salt" parcels of sapphires with colourless stones which they considered to be of little or no value. They found out that the buyers "did not object as long as there were not too many, and if of good quality and shape, and were placed amongst the second-class stones," so the practice continued.

Seeking information from the miners as to what stones they were getting was not successful at first, as they thought no good motive instigated the inquiry. Being satisfied on this point subsequently, samples of all the kinds of stones were submitted for examination.

Mr. McCrystal and party, working on their claim on the south side of Policeman Creek, having sent a parcel of stones away to a dealer, kept back a few of the doubtful ones for the writer's inspection, and amongst these the diamond was found. The party placed no particular value on it, further than that it might have as a "white sapphire," and think other similar stones were sent away in previous parcels. Special care, however, will be taken by the miners in future not to send away any more of these "white sapphires" as "second-grade stones."

The locality at which the diamond was found is marked on Map 2, being near the western extremity of a belt of wash on the south side of Policeman Creek. The sapphire wash on the claim consists of two layers, the top one being loose and easily worked, the bottom one of a clayey nature and on that account very troublesome to take out. It is in the clayey bottom wash that the diamond was found, and associated with it were blue and green sapphires, coarse corundum, pleonaste, zircon, quartz pebbles, "billy," and other *débris*. Fig. 12 represents a section of the deposit where the diamond was found.

Fig. 12.



Section of the Excavation in which McCrystal's Diamond was found.

South of Policeman Creek.

The form of the diamond is a combination of the octohedron, triakis octohedron, and hexakis octohedron, as shown on Pl. 2, Fig. 10. The general appearance suggests rounded faces, but this is the result of the oscillation or alternate development of the abovementioned forms of faces. The specimen is perfectly colourless, without a flaw, and weighs one and a-quarter carats. Since the finding of this specimen two others have been unearthed, it is said, near Retreat Creek.

The finding of diamonds at Anakie is the first instance of these stones being recognised in Central Queensland.

10.—LIST OF MINERALS FOUND IN THE SAPPHIRE DEPOSITS.

- Corundum varieties—
  - Sapphire (blue)
  - Oriental ruby (red)
  - Oriental topaz (yellow)
  - Oriental peridot (green)
  - Oriental chrysoberyl (yellowish green)
  - Oriental amethyst (purple)
  - Cat's eye (smoky, &c.)
  - Oriental Moonstone (pearly)
- Spinel varieties—
  - Spinel ruby
  - Pleonaste
- Garnet—pyrope
- Zircon varieties—
  - jargoon (white and yellow)
  - hyacinth (brown and red)
- Quartz varieties—
  - rock crystal (colourless)
  - amethyst (purple)
  - cairngorm (smoky)
- Chalcedony varieties—
  - carnelian (red and yellow)
- Jasper varieties—
  - black (lydianstone), red, brown
- Rutile—(in quartz pebbles)
- Topaz (white)
- Diamond
- Magnetite
- Titanic iron
- Magnesite
- Tourmaline
- Hornblende.

11.—HINTS TO SAPPHIRE MINERS.

(a) Hardness of Minerals.

The test of hardness is not properly understood by many of the miners. In comparing the hardness of an unknown mineral with that of a known one, the tests should be made on sharp edges and clean perfect faces, otherwise the result will not be reliable. As all the gemstones have a hardness above that of a good knife blade, anything below this can be discarded, and with pieces of rock crystal (7), zircon ($7\frac{1}{2}$), pleonaste (8), and corundum (9), all necessary tests can be made.

(b) Standard Weights.

As a misunderstanding frequently arises between the gem-miner and the dealer with regard to the weight of stones, the following table might prove useful:—

Gem Weights.

1 troy oz. = 24 dwt. = $151\frac{2}{3}$ carats = 480 troy grains.
1 dwt. = $7\frac{1}{2}$ carats = 24 troy grains.
1 carat = 3·17 troy grains (or 4 diamond grains).

The parts of a carat are expressed in sub-multiples of 4, as $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{64}$.

(c) Mineralogical Testing of Gemstones.

A small text-book on mineralogy will also be useful to those interested in sapphire-mining, so that tests of colour, lustre, form, fracture, cleavage, hardness, and other properties can be applied to the stones. With a set of blowpipe appliances additional tests may be made. "Gems and Precious Stones," by H. G. Smith, Mineralogist to the Technological Museum, Sydney, is the title of a book specially adapted for Australian readers.

12.—HISTORICAL NOTES.

Inquires have been made regarding the discovery of sapphires in the Anakie District, and the subsequent development of the deposits containing them. It seems that at about the year 1875 Mr. Richardson, a railway surveyor, found some red zircons on Retreat Creek and sent them away to be tested, thinking they might be rubies, but the sapphires which were present with them failed to attract his attention.

In April, 1876, John Evans, who was a prospector for gold, reported that sapphires occurred in a gully and on a ridge near Retreat Creek. The position is 150 yards from the house on the freehold block, on the north side of the creek, now the property of the Withersfield Sapphire Syndicate. Mr. Dobson, an old resident of Retreat Creek, states that Mr. Evans also found at about the same time sapphires at the foot of a tree near the Old Basalt Hill auriferous workings.

In 1881, Mr. Blair, manager for Mr. Richardson, opened up the deposits where Evans found the sapphires on Retreat Creek, and in 1890 Mr. Fisher became a partner of Mr. Richardson in the sapphire-mining operations. In 1891 Mr. Ballard took up an area of ground next to that of Richardson and Fisher's, and this ultimately became the property of the Withersfield Sapphire Company, of which Mr. Spier and Dr. Stuart were the principals. In 1892 Messrs. Duke and Newsome each took up areas of sapphire-bearing ground, and later on operations were started by the Oriental Sapphire Company, and by the Withersfield Sapphire Syndicate in 1900, with Mr. Spier as managing director. Messrs. Richardson, Fisher, Spier, Newsome, Logan, and Dr. Stuart have each thrown a lot of energy into the sapphire work and otherwise assisted in pioneering the industry and in drawing the attention of gem dealers to the rich quality of the stones.

At the beginning of operations in sapphire mining very few men were engaged, but at present there is a permanent population of about 200 individuals on the fields.

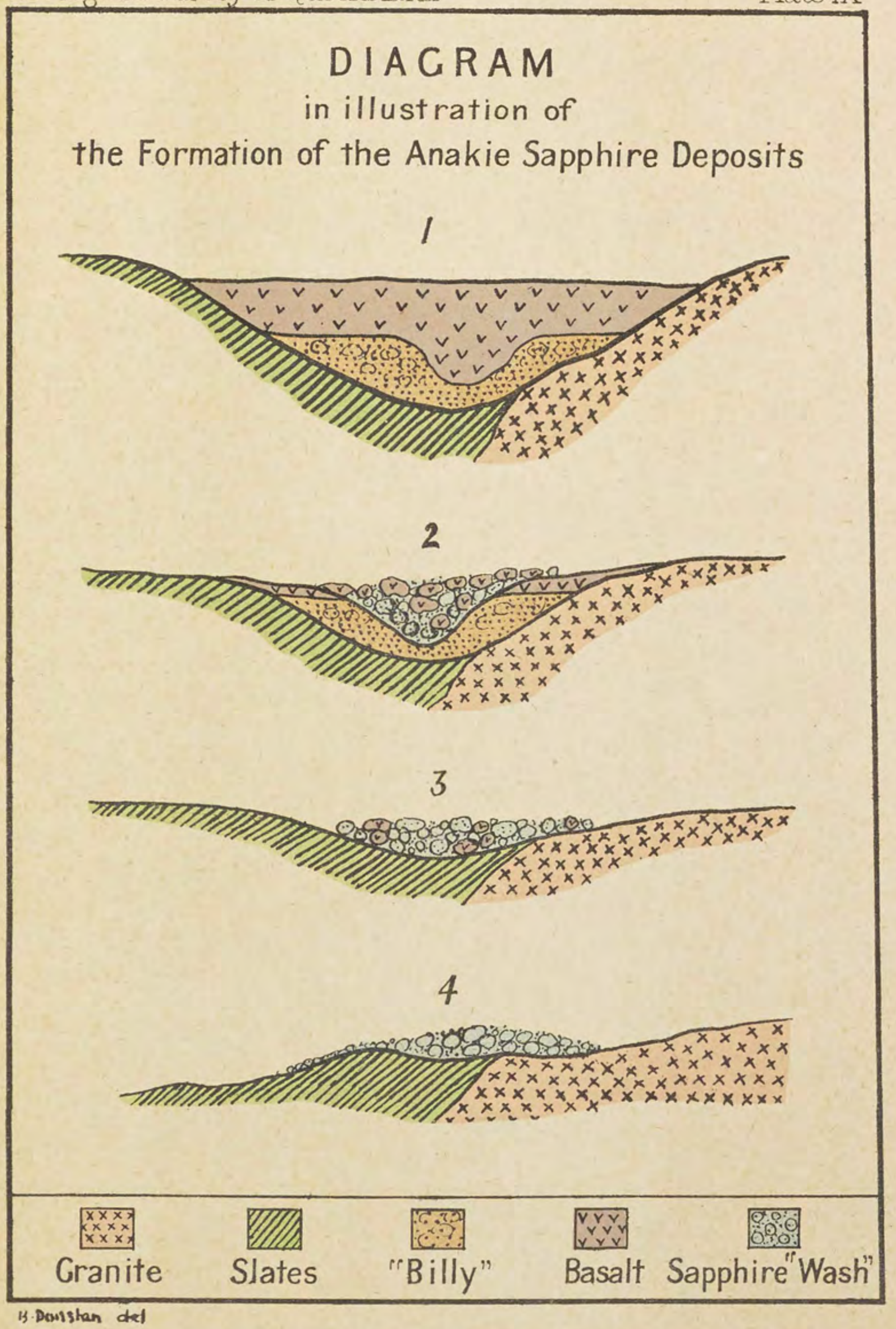


DIAGRAM
in illustration of
the Formation of the Anakie Sapphire Deposits
1
2
3
4
Granite
Slates
"Billy"
Basalt
Sapphire "Wash"
B. Dunstan del

13.—NOTES ON FOREIGN SAPPHIRE MINES.

Of the many localities where sapphires occur in other parts of the world, those of Ceylon, Cashmere, Upper Burma, Siam, and Montana are the most important.

In *Ceylon* the sapphires are found in both old and recently formed river gravels, in association with other gemstones. They occur at depths varying to twenty feet below the surface, but usually are found much shallower. The colours are blue, of many shades between dark and very pale blue. White and yellow stones are also present, but rare.

At *Cashmere* the sapphires occur high up in the Himalaya Mountains, in a garnetiferous gneiss and crystalline limestone. These matrices are decomposed on the surface, and the sapphires can be easily extracted from them, but, where the rocks are hard, great care and trouble are necessary in their extraction. The shades of colour are mostly in blues and bluish-greys, and rarely yellow, red and brown, while a great proportion of these are either " milky" or " silky."

In *Upper Burma* the stones are found in a river gravel, in surface soil, and *in situ* in crystalline limestone. The gravel and soil deposits have been derived from the limestone, but it is in the gravels that the more important mines are situated. The colours are white, blue, yellow, and red, and some of these are opalescent, the blues and reds being the more common. The blues, generally, are larger stones than the reds, but are inferior to them in quality.

The *Siam* mines produce the finest blue sapphires in the world. The stones are in a clayey gravel a few feet in thickness, and occur about two feet below the surface. The colours are red and blue of varying shades. Most of the small stones (one carat and under) are inferior in colour, while the large stones are generally perfect.

In America, before the Montana deposits were discovered, the stones produced were of bluish-green and yellow tints, and " although immense quantities of these stones are obtainable they are of small commercial value on account of their unmarketable colour." At Yogo, Fergus Co., Montana, a dyke rock is the matrix of the sapphires. They were first found in some auriferous gravels which form terraces above the present river bed, but later on they were discovered in a decomposed dyke rock between walls of limestone. This decomposed dyke rock has since been traced along the surface for a distance of five miles. In depth the rock is undecomposed and compact, and is found to consist of brown mica and plagioclase, being a variety of lamprophyre. The colours of the Montana sapphires are shades of blue, bluish-green, light green, yellow, and red, and some of the blues are said to approach the standard of colour known as "cornflower" blue. The only mineral associated with the sapphires is iron pyrites, which occurs in the form of grains.

Siam sapphires may be taken as the type of "cornflower" blues, compared to which Burma stones may be generally considered too dark, Ceylon stones too light, and Cashmere stones too milky. Each of these localities, however, produce good blues, but in all of them the light green and yellowish green stones, of which the Anakie miners are so proud, are exceedingly rare.

14.—CONCLUSION.

In the preceding pages no reference has been made to the value of the yields of sapphires obtained by the Anakie miners. Under the best conditions of any gem industry there is a considerable fluctuation in the value of the stones, and this is more noticeable where the industry is a young one, and where the stones have not become "standardised." With the Anakie stones, therefore, any estimate of value to be reliable must be based on absolute returns, but as such returns are not available, although those interested have had no hesitation in giving information about quantities and qualities, the estimate of absolute values must be left a blank.

An approximate estimate, however, has been prepared by one who has a knowledge of the Anakie sapphire trade, and shows that up to the time of the inspection about £5,000 worth of sapphires have been sold to English, American, Continental, and Intercolonial dealers. This estimate seems to be a very low one, as within the last twelve months there has been, on an average, about 100 miners on the field, who must be earning enough to keep them in rations, &c. As the cost of rations would be about 10s. per week, there would be a total distribution amongst the miners, on this basis alone, of about £2,500 a year, and this is half the total estimated value of the gems obtained during the whole time the mines have been opened.* Probably a more accurate estimate of the value received by the miners from the stones sent away from the fields would be £10,000.

In sapphire mining a parallel may be drawn with ordinary auriferous alluvial deposits, where one claim might be yielding handsome returns while the adjoining one is not even payable—an ordinary experience in both classes of mining. With sapphire mining one man is doing well when he is obtaining, perhaps, two or four ounces of mixed stones per day, another just making a living at one ounce per day, while a third miner not getting more than half-an-ounce will find in this a few stones weighing a couple of pennyweights worth more than the whole of another man's four ounces. On one claim, perhaps, a man will obtain very few stones and of no value, and when on the point of abandoning it finds, it may be, a stone worth £20 or £30, or at the beginning of his work a miner may find a valuable stone and, under what might appear favourable conditions, spend considerable time looking for more without success. As with alluvial gold mining, some will consider its prospects very good because they obtain good results, while other miners, less fortunate, will look upon the industry with disfavour.

One marked difference exists, however, between the two classes of mining in that gold has a standard value and a gold-miner knows the value of his yield as soon as it is weighed, while a sapphire miner after finding his sapphires has to obtain a market for them, and having obtained a market he will only know the result of the transaction perhaps months after the stones have passed out of his possession.

Dr. Jack, in the report previously quoted, has estimated the returns from some of the mines. He states that from a ton and a-half of washdirt he obtained " 254 sapphires of from 3 to 179 carats each, and weighing in all 3,289 carats," but during the present inspection such results were not obtained, half these quantities being about the maximum.

Regarding the prospects of the field, there is no doubt whatever in stating that they present a most favourable aspect. Miners are always arriving on the fields, discoveries of sapphire country are constantly being reported, and, what is perhaps of more importance, there is an ever increasing demand for the stones. Although fresh discoveries of sapphire country are being made, yet the western fields of Tomahawk and Central Creeks, where the most extensive areas exist, have not been prospected to any extent. Natural conditions here are unfavourable, and because of the undeveloped state of the country, progress is greatly impeded. The country is badly watered, a great inconvenience to prospectors both in getting to the fields and afterwards in exploring them, and the distance from Anakie, the source of supplies, is too far for prospectors to take rations unless they are provided with horses, a provision which is out of the question with most of them.

Although the existence of the industry in the past has depended entirely on the individual perseverence of those who are or have been engaged in it, yet it should receive more attention from those interested in the gem industry, and more encouragement from those interested in the development of our mineral resources.

15.—DESCRIPTION OF PLATES.

Plate 1.

Corundum crystals showing form, cleavage, and corrosion marks.

Figs. 1, 1*a*.—A waterworn crystal of corundum exhibiting both basal and rhombohedral cleavages. Fig. 1*a* is a section of the crystal along the line A.B.

x 1¼ size. *Loc.*, Newsome's Claim, Retreat Creek.

Fig. 2.—A crystal of corundum with rounded edges and faces, showing on its fractured surfaces the effects of both corrosion and erosion. A small crystal has been attached to the side of the larger one.

1¼ size. *Loc.*, Newsome's Claim, Retreat Creek.

Fig. 3.—Diagram illustrating the general appearance of the rhombohedral cleavages where they intersect a basal section. The arrows indicate the direction of inclination of the cleavage planes.

Fig. 4.—Natural surface of portion of sapphire showing corrosion. The markings are more granular than those in Fig. 6, and suggest being formed on faces rather than on the edges of cleavage planes.

Nat. size. *Loc.*, Tomahawk Creek.

Fig. 5.—Corundum crystal. On the basal plane (*b*) a rhombohedral development (*a*) has taken place. The shaded portions (*c*, *cc*) represent what appears to be indistinct prismatic and pyramidal faces.

Nat. size. *Loc.*, Tomahawk Creek.

Fig. 6.—Natural surface of portion of sapphire showing corrosion markings. The markings are elongated and seem to have been formed along the edges of cleavage planes.

x 1½. *Loc.*, Tomahawk Creek.

Plate 2.

Structures in corundum and "billy" and forms of pleonaste and diamond.

Fig. 1.—A fragment of corroded pleonaste. The surface is marked with small circular depressions.

Nat. size. *Loc.*, Newsome's Claim, Retreat Creek.

Figs. 2, 2*a*.—Two views of a crystal of pleonaste. The faces are curved, slightly distorted, and are covered with minute etchings.

x ½. *Loc.*, Mount Leura.

Figs. 3, 3*a*.—Two views of a blue and yellow sapphire crystal, showing pyramid (*a*) and prism (*b*) of second order, and two rhombohedrons of the first order. One rhombohedron is obtuse (*c*), the other very acute, and forming a yellow core inside (*e*). The basal terminal plane (*d*) forms the end of the acute rhombohedron, their edges coinciding.

Forms :—$(11\bar{2}1)$, mP2 (*a*) ; $(11\bar{2}0)$, ∞P2 (*b*) ; $(10\bar{1}1)$, R (*c*) ; (0001), OP (*d*).

x ½. *Loc.*, McCrystal's Claim, Policeman Creek.

Figs. 4, 4*a*.—Fig. 4 represents a polished basal section of corundum, and shows a small internal prism of the second order, and rhombohedral cleavages. The cleavages also appear to penetrate the small crystal, although, as shown in Fig. 4*a*, this might result from the building up of the crystal in a series of flat superimposed individuals between which some films of the larger crystal are formed as alternations.

x 6. *Loc.*, McRichie's Claim, Retreat Creek.

Fig. 5.—Another polished basal section of corundum, showing a marked development of one set of rhombohedral cleavages.

x 1½. *Loc.*, Newsome's Claim, Retreat Creek.

Fig. 6.—Basal section of portion of corundum showing prismatic zonal lines and rhombohedral cleavage lines, and producing a "sagenitic" structure.

x 2. *Loc.*, Newsome's Claim, Retreat C eek.

Figs. 7, 7*a*.—Two views of a distorted crystal of pleonaste. On one abnormally developed face there is a group of three faces of the triakis octohedron. On other portions of the crystal, these faces are indicated by fine lines bordering the octohedral faces.

Nat. size. *Loc.*, Godlipp's Claim, Retreat Creek.

Figs. 8, 9.—Sections of quartz grains in enclosed pebbles in the altered rock "billy." A second growth of the quartz has taken place from the surface of the pebbles, showing no line of break between the interi r (old) and exterior (new) portions, and both having the same optic orientation.

Slide 12. x 50 *dia.* *Loc.*, W.S.S. Reward Claim, Sheep Station Creek.

Fig. 10.—McCrystal's diamond. The traces of the octohedron, triakis octohedron, and hexakis octohedron, are distinctly seen. In the drawing the crystals appear too prominently rounded.

Loc., McCrystal's Claim, Policeman Creek.

Plate 3.

Inclusions in basalt—macroscopic and microscopic.

Fig. 1.—Crystal of pleonaste partly destroyed by corrosion. Imbedded in basalt.
x $\frac{3}{4}$. *Loc.*, Mount Leura.

Fig. 2.—Corroded crystal of ilmenite (titanic iron), imbedded in basalt.
x $\frac{3}{4}$. *Loc.*, Mount Leura.

Fig. 3.—Bleb of pleonaste in basalt, naturally weathered.
x $\frac{3}{4}$. *Loc.*, Mount Hoy.

Fig. 4.—Bleb of pleonaste with bright surfaces, weathered out of basalt.
x $\frac{3}{4}$. *Loc.*, Mount Newsome.

Fig. 5.—Crystal of zircon (var. hyacinth), showing corrosion marks. The countersunk portions have bright surfaces, while the elevated portions are dulled by subsequent abrasion.
x $\frac{3}{4}$. *Loc.*, McCabe's Claim, Retreat Creek.

Fig. 6.—Portion of weathered granite fragment showing idiomorphic tourmaline (*b*), in quartz (*c*), both in the interstices between crystals of orthoclase. (*c*)
x $\frac{3}{4}$. *Loc.*, base of Mount Leura.

Fig. 7.—Inclusion of hornblende and plagioclase in basalt. Severe corrosion has taken place on the edges.
Nat. size. *Loc.*, Policeman Creek.

Fig. 8.—Fragment of pleonaste corroded to a spongy mass.
x $\frac{3}{4}$. *Loc.*, Mount Leura.

Fig. 9.—Portion of plagioclase inclusion in basalt. A kaolinised film exists between the mineral and the rock.
x $\frac{3}{4}$. *Loc.*, Mount Leura.

Fig. 10.—Crystal of augite in basalt, exhibiting corrosion, internal alteration, and an external zone free from alteration or inclusions.
Slide 7. x 15. *Loc.*, Mount Leura.

Fig. 11.—Section of basalt showing the formation of laths of felspar around a bleb of pleonaste.
Page. x 15. *Loc.*, Mount Hoy.

Fig. 12.—A rounded bleb of olivine in quartz. Olivine (*a*), magnetite (*b*), plagioclase (*c*), augite (*d*).
Slide 6. x 15. *Loc.*, Mount Newsome.

Plate 4.

Diagram showing the effect of pleochroism in the cutting of Anakie blue sapphires.

Fig. 1.—Colour of the sapphire observed in the direction of the principal axis—*i.e.*, observed at right angles with the basal cleavage.

Figs. 2 to 5.—Colours of different crystals observed at right angles with the principal axis.

Figs. 6 to 9.—Colour effects when the "table" of the stone is at right angles with the principal axis—*i.e.*, parallel with the basal cleavage.

Figs. 10 to 13.—Colour effects of the "table" when cut parallel with the principal axis—*i.e.*, across the basal cleavage.

A stone with the blue colour (1) on the basal cleavage plane, and with the pale green (5) at right angles with it, will produce the colour (9) if cut correctly, but if cut otherwise—at right angles with the cleavage—it will be dichroic, showing a confusion of the two colours (1) and (5), but with increased depth, as in (13).

Another example: With the same, or nearly the same blue colour (1) on the "top" or cleavage plane and the colour (2) on the "side," effects are produced as in (6) and (10) according as the table is made on the "top" or "side" respectively. In this example, a fine blue stone as seen in one direction, and a decided green in the other direction, when cut either way would produce a dark and almost useless gem.

Plate 5.

Illustrations of Cut Gemstones.

(All the figures represent corundum varieties except Fig. 7, this being a hyacinth.)

Figs. 3 and 8 are pure blues of two shades, rare colours in Anakie sapphires.

Figs. 1, 4, and 12 are greens of the oriental peridot type.

Figs. 5 and 9 represent yellowish green stones of the oriental chrysoberyl type.

Figs. 6 and 13 exhibit two shades of oriental topaz, one, Fig. 6, being canary yellow, the other, Fig. 13, an amber yellow.

Figs. 2 and 11 represent two cat's-eyes, Fig. 2 being of a greyish tint; Fig. 11 a bluish white.

Fig. 7.—Represents a dark-red hyacinth. Some stones vary considerably from this in being lighter in tint and also in having more brown mixed with the red.

Plate 6.

Corundum Crystals.

(All natural size.)

Fig. 1.—Smoky, barrel-shaped crystal, showing traces of rhombohedral cleavages.
Loc., Newsome's Claim.

Fig. 2.—Pyramid showing obliteration of two pyramidal faces (reversed in drawing).
Loc., Newsome's Claim.

Fig. 3.—Crystal showing terraced structure resulting from alternate development of faces of prism and basal plane.

Loc., Halliday's Claim, Policeman's Creek.

Fig. 4.—Vertical section (along the principal axis) showing the building up of different coloured corundum.

Loc., Newsome's Claim.

Fig. 5.—Crystal showing zonal bands and a modified "hour glass" structure. The crystal is tabular, the only specimen observed having this character.

Loc., Retreat Creek.

Fig. 6.—An acute rhombohedron of yellowish colour. The trace of another obscure face is also shown.

Loc., Newsome's Claim.

Fig. 7.—An opaque blue and bronze-coloured crystal. The trace of the rhombohedral twinning plane is also shown.

Loc, Andrew's Claim, Retreat Creek.

Fig. 8.—Smoky crystal, showing rhombohedral developments on the basal plane.

Loc., Reward Claim.

Fig. 9.—Six-rayed corundum, with a centre showing hexagonal section. The rhombohedral cleavages are well marked, and there are traces of zonal banding.

Loc., Newsome's Claim.

Fig. 10.—Ruby-coloured semi-opaque crystal of corundum, with traces on the prism faces of blue banding parallel to basal plane.

Loc., Newsome's Claim.

Fig. 11.—Structure similar to that represented in Fig. 3. The development of the terraced structure has been uniformly around the crystal.

Loc., Reward Claim.

Fig. 12.—Pale-blue sapphire, with smoky schiller (?) inclusions along rhombohedral cleavage planes.

Loc., Newsome's Claim.

Fig. 13.—A crystal showing bright-blue, ruby, and purple colours on the basal plane. These colours at right angles with the optic axis are pale green, rose red, and purplish green.

Loc., Newsome's Claim.

Fig. 14.—Basal section showing red centre and semi-opaque blue on the periphery.

Loc., Newsome's Claim.

Fig. 15.—Very pale ruby. Fig. 15 shows the colour on basal plane; Fig. 15*a*, the colour at right angles with it.

Loc., Newsome's Claim.

Fig. 16.—Bluish-green sapphire, coloured blood red by film of hematite in a flaw in the centre.

Loc., Andrew's Claim, Retreat Creek.

Plate 7.

Corundum Crystals.

(All natural size.)

Fig. 1.—Blue sapphire with yellow centre. Basal section. The Yellow triangle is a portion of an acute rhombohedron. No specimen has yet been found having a blue centre with yellow surrounding it.

Loc., Tasmanian's Claim, Retreat Creek.

Fig. 2.—Basal section of blue crystal with ruby bands.

Loc., Newsome's Claim.

Fig. 3.—Green zonal band on blue prism.

Loc., McRichie's Claim, Retreat Creek.

Figs. 4, 5.—Blue basal terminations to dark prisms. In Fig. 4 the blue is at both ends.

Loc., Newsome's Claim (both).

Fig. 6.—Basal section showing three very dark triangles in an opaque corundum crystal. Structure undeterminable.

Loc., Reward Claim.

Fig. 7.—Pyramid of corundum with clear light blue segments alternating with smoky segments parallel with basal plane.

Loc., Hunt's Claim, Retreat Creek.

Fig. 8.—(Blank).

Figs. 9, 9*a*.—Two views of one crystal. A normally developed yellow crystal with a subsequent (?) addition of blue on one of its prism faces.

Loc., Poverty Hill.

Fig. 10.—Section of a yellow di-hexagonal pyramid or prism in a greenish corundum.

Loc., Newsome's Claim, Retreat Creek.

Fig. 11.—Pale-blue crystal with apex of deeper blue.

Loc., Retreat Creek.

Fig. 12.—Yellow rhombohedron enclosed in bluish-green prism. Vertical section.

Loc., Rice's Claim, near Reward Claim.

Fig. 13.—Yellow and brown corundum in alternating bands. Basal section.

Loc., Reward Claim.

Fig. 14.—Partial yellow banding in blue crystal. In one part of the section (basal) the yellow bands have diminished to fine lines.

Loc., Newsome's Claim.

Figs. 15, 15*a*.—Yellow crystal with banded and smoky rhombohedral development. Fig. 15 shows end view. Fig. 15*a* is a vertical tangential section (*see* dotted line on Fig. 15) showing the rhombohedral structure.

Loc., (?)

Fig. 16.—Two views of rather flat crystal showing a yellow band between two others which are smoky-brown. Fig. 16 shows the zonal banding present in the smoky portion, and absent from the yellow.

Loc., Newsome's Claim.

PLATE 8.

Sapphire Washing Plant at Policeman's Creek.

a. Windlass.—The supporting logs are lengthened to accommodate the long water-supply trough.

b. The water-supply trough (end view) is made from a hollow log. It supplies the wet-jigger (*d*) and puddling trough (*f*). The pipe and cock shown in the sketch may be replaced by canvas hose, siphon, &c.

c. Sprinkler.—Made of sheet-iron spouting, and perforated according to the supply of water required. The wash might be clayey, necessitating being well washed.

d. The wet-jigger with perforated iron or woven-wire bottom. Size of mesh $\frac{1}{8}$ inch to $\frac{3}{16}$ inch. The motion is a horizontal shaking one of 4-inch throw.

e. Sorting table.—Covered with sheet-iron and placed below the level of the wet-jigger.

f. Puddling trough.—Its use is necessary to remove soft clayey matter and also to wet the wash-dirt before jigging.

g. Tailings.

Working the Plant.

The operation consists in placing the wash-dirt into the puddling trough (*f*), supplying water from the well, working the dirt with a shovel or flat wooden blade, throwing the dirt on to the wet-jigger, and turning on the sprinkler and shaking the jigger for a minute or two.

The finer portions fall through the jigger and are washed away. The coarser portion remaining in the jigger is spread over the sorting table, and the gemstones picked out. The refuse is then thrown on to the tailing heap.

PLATE 9.

Diagram in illustration of the formation of the Anakie Sapphire Deposits.

Fig. 1.—This figure shows pre-existing conditions. The sapphire-bearing basalt has overflowed a deposit of altered sandstone ("billy"), the bedrock of which is slate and granite.

Fig. 2.—The next stage shows the partial removal of the basalt and "billy," and the accumulation of *débris* in a channel in which the gemstones are contained.

Fig. 3.—The basalt and "billy" as rock masses have now been entirely removed. The sapphires remain behind with the *débris* on the slate and granite.

Fig. 4.—This figure represents the conditions at the present time. The slates have become decomposed, and, where not protected from rain by the boulders of "billy," have been weathered down, while the sapphire wash, mixed with the "billy" boulders, remains in its original position, but which, instead of being in a depression, now occupies an elevated position.

PLATE 10.

Sapphire Washing Plant (Newsome's).

a. Paddock cut out of the side of the bank of Retreat Creek. The dirt is tipped over the top of the bank, and, after a number of loads have accumulated, it is washed in the plant below.

b. Puddling trough where the dirt is puddled or soaked before jigging.

c. Supply tank for trough and jigger.

d. Supply pipe for trough.

e. Wet-jigger (end view).—Its four springs (legs) are fixed to a frame embedded in the ground.

f. Sprinkler, in front of tank (*c*) and above wet-jigger (*e*).

g. Sorting table at the end of jigger.

h. Barrow for removing tailings thrown from the table.

i. Well in bed of Retreat Creek.

j. Iron bucket attached to wire rope passing through pulleys *k* and *kk*, and travelling between two guide wire-ropes fastened to bottom of well.

k. Fixed pulley leading on to movable pulley *kk*.

l. "Circular whip" worked by horse (on the same principle as an alluvial puddling machine). The wire-rope leads from the pulley *kk* to the horizontal beam of the circular whip, and as the horse travels around the path the bucket in the well is lifted. The height of the lift is regulated by the point of attachment of the rope on the beam of the whip, and can be adjusted very accurately.

m. The bucket as it is being emptied at its extreme height. One end of a chain, a few feet in length, is fastened to the lip of the bucket, the other end having a ring attached which slides up and down a third wire-rope as the bucket is elevated or lowered. The position of the chain is also shown when the bucket is in the well. As the bucket rises high enough for emptying, the ring at the bottom end of the chain catches against a stop in the wire-rope and prevents the lip of the bucket rising any higher. The hauling-rope continues a few inches further, and by the pull on the lip the bucket is tilted to one side and the contents emptied into the launder (*n*) which delivers into the tank (*e*).

Plate 11.

Section of Sapphire Deposits at Retreat Creek.

a. The "top wash."—The material composing this is "billy" basalt, quartz, &c. One boulder to the right of the section shows a very irregular outline, a characteristic form.

b. A clay deposit, forming a false bottom to the wash. It is well defined in places, but absent altogether in others. Sapphires are sometimes found imbedded in it to the depth of a few inches.

c. The "bottom wash." Similar in composition to the upper wash. Several claims were supposed to have been worked out after the upper wash was removed. Later developments show the lower wash to be as good as the top one.

d. The bedrock of slates and schists of various kinds. The lower wash and the surface of the bedrock are sometimes so much alike that a difficulty is frequently experienced in distinguishing the bottom of the alluvial deposits from the top of the decomposed slate.

Plate 12.

Geological Sections.

Section A to B.—This is taken across Mount Hoy and Mount Leura, and shows the general features of the Drummond Beds, with their conglomerates, the head of the sapphire belt at the base of Mount Hoy, and the granite and isolated basalt peaks towards Mount Leura From such a section it would be more reasonable to suppose the sapphire-bearing basalt came from Mount Hoy with its underlying shales and other rocks, than from Mount Leura, whose base is granite.

Section C to D.—This section is taken across the old basalt workings (Basalt Hill), where the zircons occur in the alluvial deposits below basalt, to Mount Pleasant and Mount Bullock, and thence along the Retreat Creek sapphire deposits. Copper occurs near the junction of the slate and diorite near Mount Pleasant.

[No. 172 of the Geological Survey Publications.]

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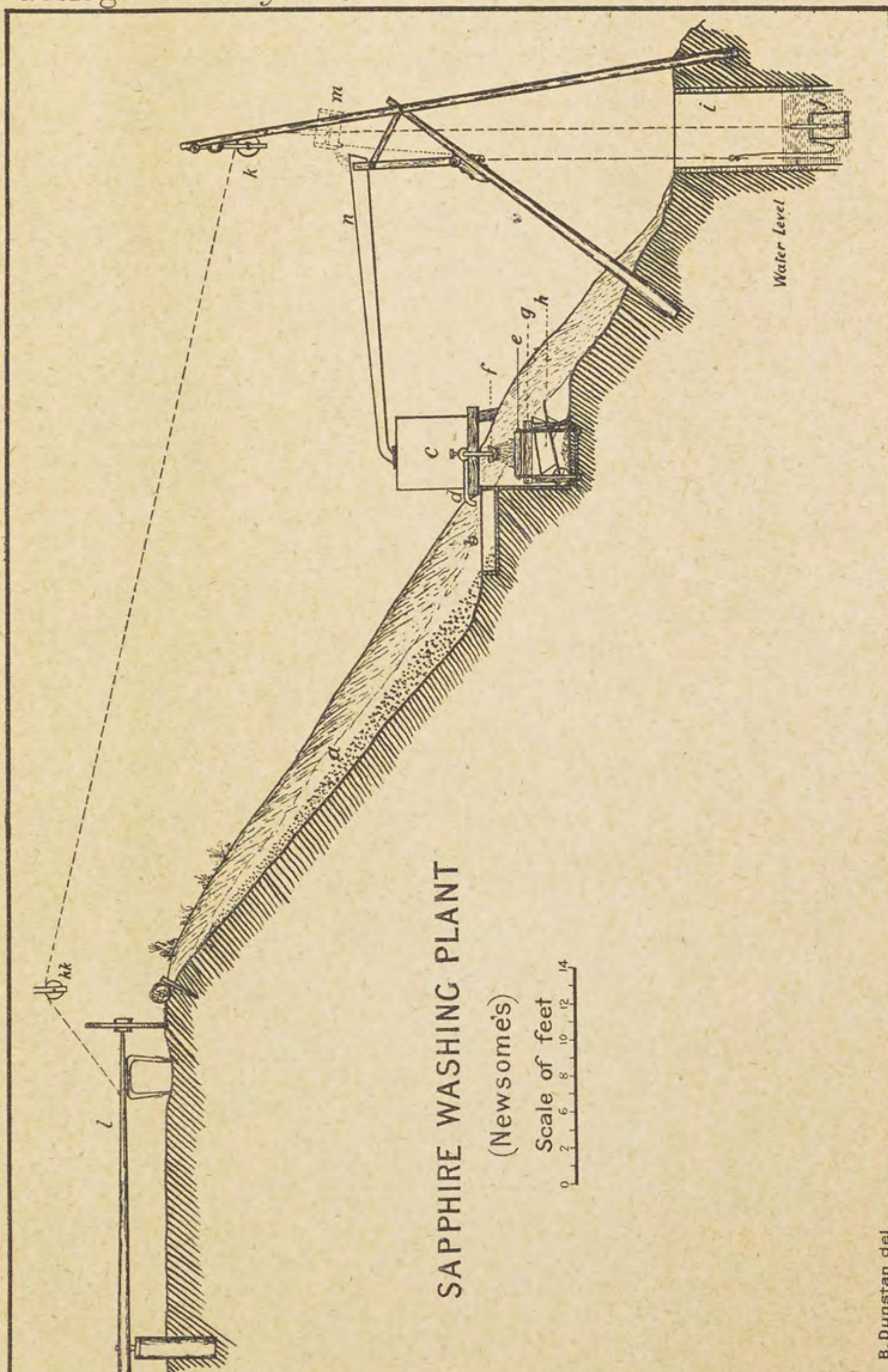
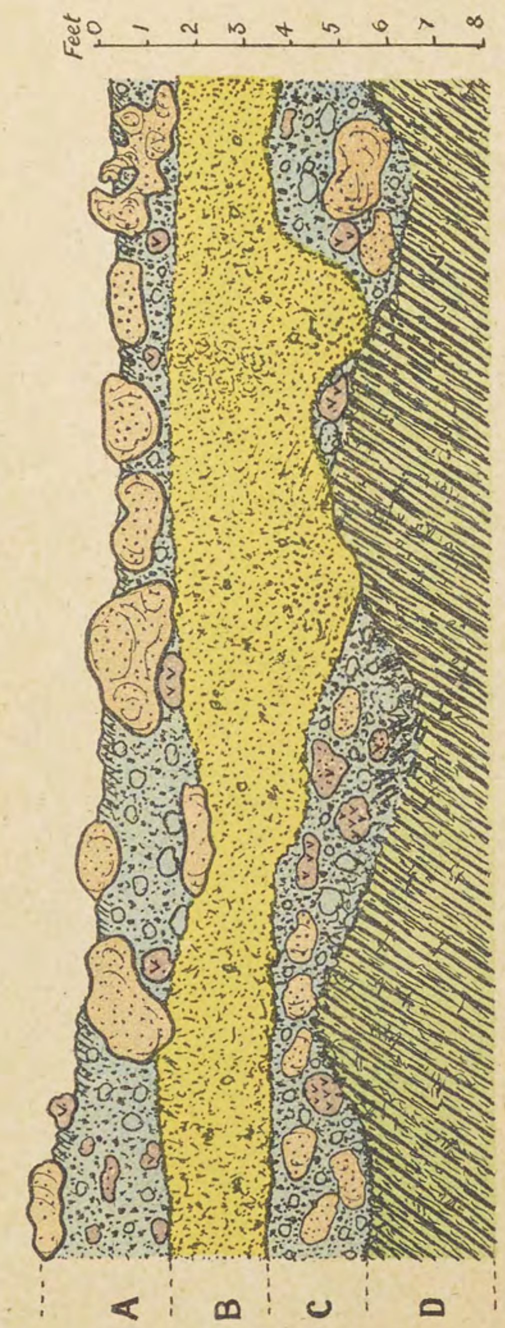

SAPPHIRE WASHING PLANT
(Newsome's)
Scale of feet
0 2 4 6 8 10 12 14
Water Level
B. Dunstan, del.

SECTION OF SAPPHIRE DEPOSITS AT RETREAT CREEK

Showing two distinct beds of "Wash"



A. Top Wash B. Clay deposit C. Bottom Wash D. Slates, Schists, &c.

B. Dunstan del.

GEOLOGICAL SKETCH SECTIONS

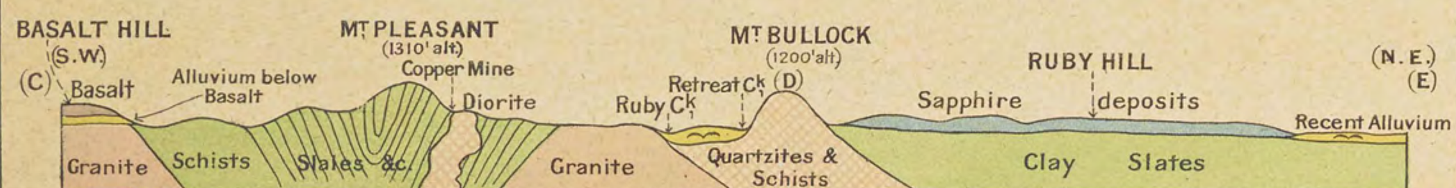
Accompanying Report on the Anakie Sapphire Field

CENTRAL QUEENSLAND

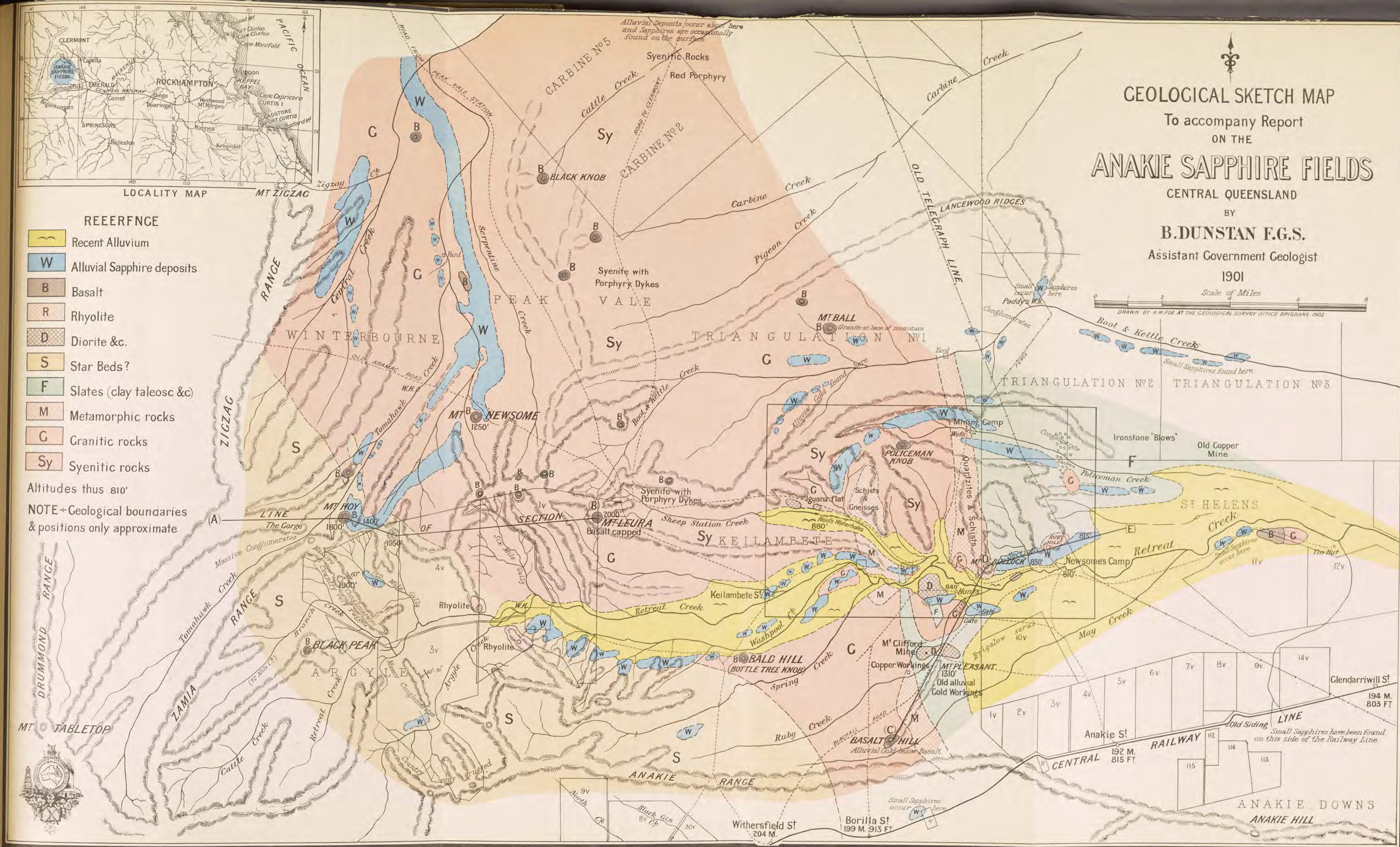
By B. DUNSTAN, F.G.S.

The Sections are along lines shewn on accompanying Geological Map

Length of Section about 10 Miles



Length of Section about 10 Miles



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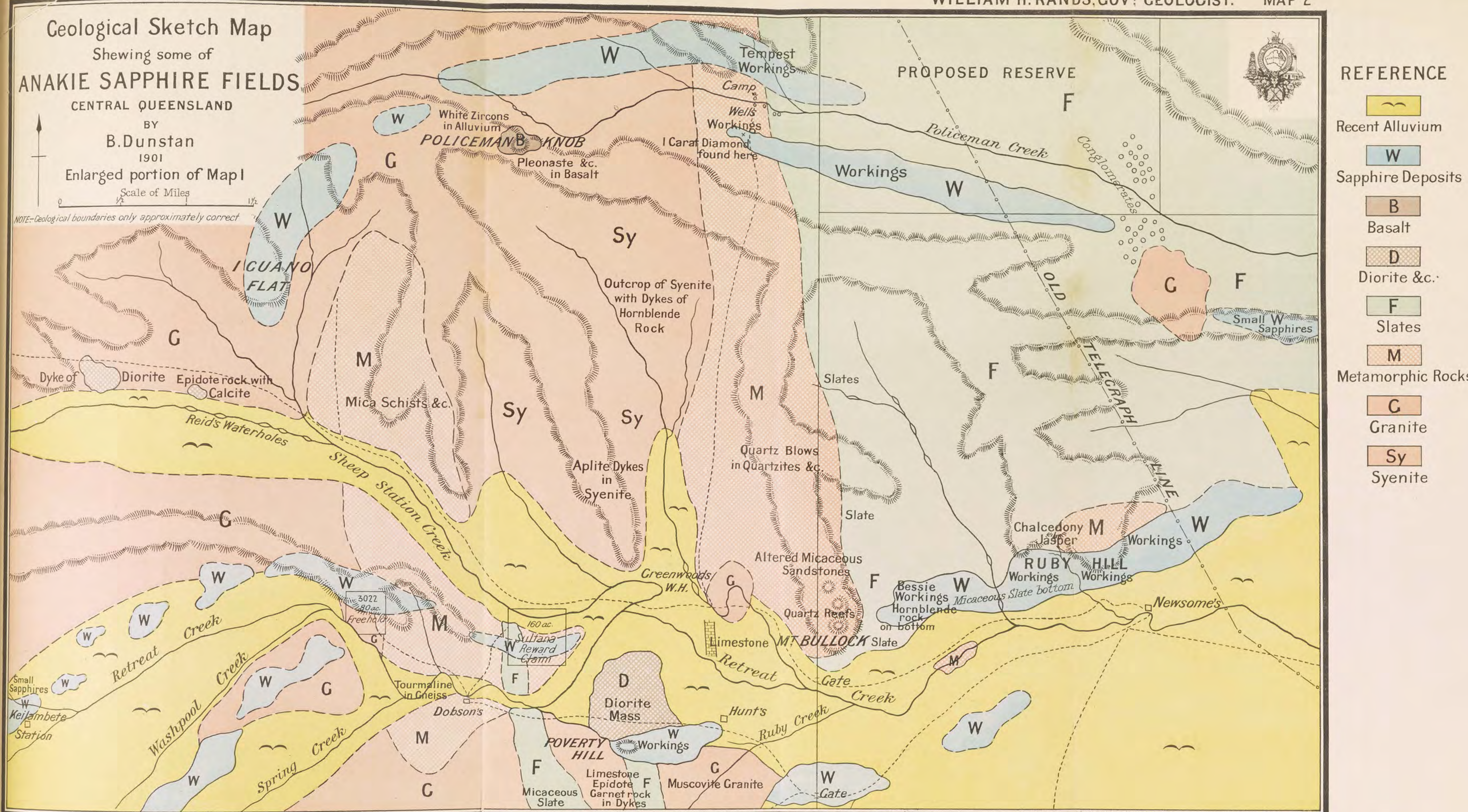

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